10 Rechargeable Batteries with Nanotechnology

Meenal Gupta, Santosh J. Uke, Yogesh Kumar, Sweta Sharma, Ashwani Kumar, Pushpa Singh, Amit Saxena, Bhaskar Bhattacharya, and Yogesh Kumar

CONTENTS

10.1 INTRODUCTION

Electrochemistry is a discipline of chemistry that studies chemical processes that produced at electrodes. Electrochemistry has diver's applications in daily life; this includes electroplating, separations of salt, organic and inorganic synthesis, sensors, pollution control, energy, etc. Over the globe, the most of the electrochemist use the boon of electrochemistry especially conversion of chemical energy to electrical energy. The different batteries, supercapacitors and fuel cells are the most common gifts of electrochemistry to the mankind. The batteries are used to power a variety of devices, including electric vehicles, smartphones, electronic tablets, watches,

DOI: 10.1201/9781003216308-10

pacemakers and many others. Chemical reactions in batteries provide power that can be transformed into useful work. The transport of the electrons also occurs in the electrode material, electrode current collector interface and outer circuit in electrochemical applications. The processes take place in a system called the cell. In many systems, the reactions take place in a cell, where electrons are transferred between electrodes.

A rechargeable battery is an electrical device, which has many electrochemical cells together. Batteries involve electrically reversible electrochemical reactions and therefore known as secondary cell. While discharging of the battery, stored charges depleted slowly however during charging chemical reaction get reversed to restore new charges. With the advent of portable devices such as notebook computers, cell phones, MP3 players and cordless power tools, the demand for rechargeable batteries has increased dramatically in recent years. In 1859, the invention of lead-acid element by French physicist Gaston Plante opened a research filed toward new technology based on battery and still researches are going on battery system. Plante batteries with lead anodes, lead dioxide cathodes and sulfuric acid electrolyte are the pioneers of modern car batteries.

Both the primary batteries (nonrechargeable) and secondary batteries (rechargeable) work in exactly similar way. Electrochemical reactions developed between the both electrodes (anode and cathode) and electrolyte to generate electricity. However, for rechargeable batteries, the reaction is reversible. When external power is applied to the secondary battery, the electron flow generated during the discharge is reversed from negative to positive and the charge of the battery is restored. After nickel-metal hydride (Ni–MH) and nickel-cadmium (Ni–Cd) batteries, the most common rechargeable battery is Lithium-ion battery (LIB), which is available in market presently. The construction of a rechargeable battery is shown in Figure 10.1 [1].

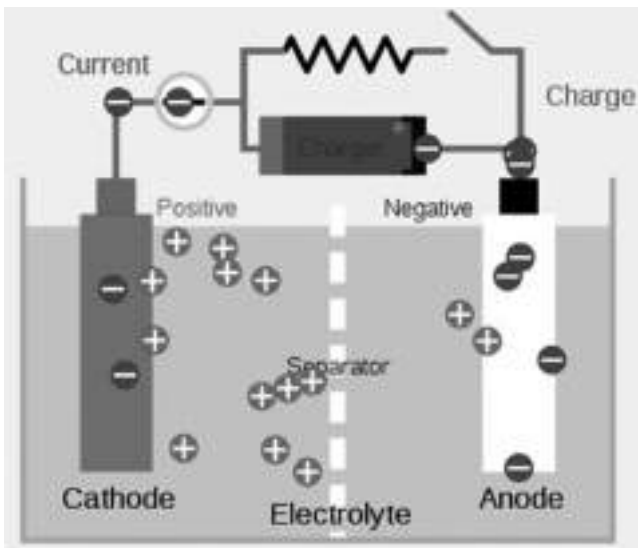


FIGURE 10.1 Construction of rechargeable battery [1].

10.2 NANOMATERIALS FOR RECHARGEABLE BATTERIES

The demand for energy materials is increasing at its fast pace; lots of new materials are been explored in order to meet the demand of the market. Nanomaterials of batteries in applications are gaining momentum day by day because of its versatile properties; it is meeting the demands of smart power enhanced and efficient batteries which can be used in electric vehicles, storage devices, plug in vehicles. In the present context, the climate change has given new dimensions for the search of those nanomaterials, which are environmentally friendly and can be easily recycled so that the dependence on fossil fuels can be minimized and the pollution can be checked at a large scale. Research on application about the nanomaterials in batteries was done by the global nanomaterials in batteries and supercapacitor market and the report predicted that the market size will grow for the period from 2021 to 2031. In Table 10.1, it has been shown the different parameters needed for the commercializations of nanomaterials in batteries. Moreover, the ongoing research in different companies of the countries for the exploration of different nanomaterials, depending on the various issues, are listed in Table 10.1.

The rechargeable batteries are becoming more and more important in our daily lives with their powerful ability to effectively store electrical energy in chemical form. Replacing traditional liquid electrolytes with polymer electrolytes (PEs) is considered to be one of the most feasible solutions for the development of higher energy density and safer electrochemical energy storage systems, which are eagerly used in electric vehicle applications. In recent years, to coordinate the advantages and to modify the material according to our needs using organic phase and the inorganic phase electrolyte, the introduction of organic–inorganic hybrid nanomaterials in PE has attracted more and more attention. Polyhedral oligomeric silsesquioxanes (POSSs) are one of the most attractive latest technologically important hybrid nanostructured

TABLE 10.1
Different Companies of the Countries for the Exploration of Different Nanomaterials Depending upon the Various Issues

Countries	Brands of the Companies	Scope and Segment	Analysis based on Following Factors
United States, Southern Asia, Canada, France, Germany, United Kingdom, South Korea, Taiwan, China, Japan, Brazil, Russia	Ampirius Inc.; BAK Power; Be-Dimensional; Bodi Energy; Dongxu Optoelectronic Technology Co. Ltd.; Nexeon; Ray Techniques Ltd.; Skeleton Technologies Group OA; HE3DA S. R. O	Company; Region (Country); Type; Application; Revenue; Forecast by region; Participants; Stakeholders	Market overview; Industry and applications; Prospects of growth in revenue; Competition in the market: Region wide consumptions and production; Upgradation in technologies; Analysis of supply chains; Landscapes

material having combined properties of organic–inorganic. In its structure, organic functional groups are attached to the inorganic nano-sized cores. POSS is known for its low density, adjustable surface properties, high thermal stability and good mechanical strength with polymers in the form of nanocomposites, which can be used as nano-filler in different systems. In recent years, the paradigm shift from solid polymer electrolyte (SPE) to nanocomposite hybrid polymer electrolyte (NCHPE) in rechargeable battery applications was highlighted mostly in many research reports.

The increases in conduction mechanism enhance the capacity of electrodes. The reduction in diffusion length in lithium ion at nanoscale is one most important application of nanotechnology in alkaline batteries. The thin films fabricated using the nanomaterials increase the transport properties of the electronic conduction. It helps in ion storage by increasing the surface area of the electrode materials. Mesoporous-ordered structure generally favors the kinetic of electrode. It also helps in enhancing the life cycle of batteries. The main area of research is to find those nanomaterials which can be used in electrodes having a high surface area as it will increase the energy density and capacity of the batteries; moreover, it will also increase the lifespan and efficiency of the batteries. Safety and cost-effectiveness are also the primary factors for the search of new nanomaterials.

The nano-batteries are also being manufactured using nanotechnology. These batteries can be combined together to form macro battery with increased efficiency. The nanomaterials can also be used as coating in order to separate the electrodes, thus causing low self-discharge. Although nanomaterials have lots of advantages, there are some shortcomings such as low density with large surface area which result in high resistance exists, thus reducing the conductivity and stability of the battery. Nevertheless, nanoparticles are also difficult to synthesize as a result the manufacturing cost increases.

There are huge potentials of nanomaterials to be used in batteries, as it can be used as a coating material for electrodes. With its use, the surface the charging time will also get reduced. The of nanomaterials is used in different battery, viz., nickel-cadmium battery, nickel metal hydride battery, LIB, sealed lead-acid battery, sodium-ion battery, etc. Nanomaterials and nanotechnology are the future of recent batteries, although there are many challenges related to its efficiency and cost, still the research studies are going to explore new materials for battery.

10.3 LEAD-ACID BATTERY

In 1859, Lead-acid batteries which are the oldest rechargeable batteries were invented by French physicist Gaston Plante. These are one of the most common secondary batteries used mostly for loading large cell potential. Lead-acid batteries are capable to supply high value of current, which requires maintaining high power to weight ratio by cells. Lead-acid batteries are low-cost batteries with high power to weight ratio; therefore, they become a suitable candidate for their use in automobiles, golf cars, forklifts and other vehicles, which require high currents. The hazards include heavy mass, incompetence under low temperatures and incapability to maintain its capacity for long intervals of time through disuse [2].

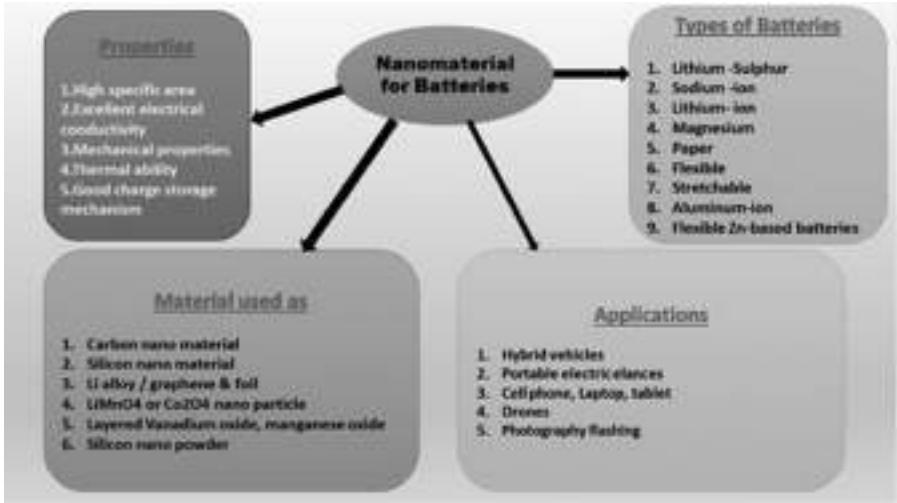


FIGURE 10.2 Nanomaterials for rechargeable batteries.

Usually, lead-acid battery consists of lead oxide (PbO_2) as cathode, lead (Pb) as anode and aqueous solution of concentrated sulfuric acid (H_2SO_4) as electrolyte. The chemistry behind lead-acid battery and its principal components are given in Figure 10.2.

The standard reversible electrochemical reactions in a lead-acid battery are shown as follows:

$$\text{At cathode}: PbO_2 + 3H^+ + HSO_4^- + 2e^- \rightleftharpoons 2H_2O + PbSO_4 \quad (10.1)$$

$$\text{At anode}: Pb + HSO_4^- \rightleftharpoons PbSO_4 + H^+ + 2e^- \quad (10.2)$$

$$\text{Overall reaction}: Pb + PbO_2 + 2H_2SO_4 \rightleftharpoons 2PbSO_4 + 2H_2O. \quad (10.3)$$

It can be seen that after complete discharge, anode and cathode both are converted into lead sulfate ($PbSO_4$); also, water produces after losing most of the dissolved H_2SO_4 in electrolyte. When fully charged, the cathode and anode are made of PbO_2 or Pb. The electrolyte converts back into concentrated H_2SO_4. The majority of the electrochemical energy is stored in such a fully charged state. Lead-acid batteries suffer with their low-energy density (~40 Wh/kg) [3] and have 85% Coulombic efficiency and 70% energy efficiency. They have the lowest storage capacity of any other rechargeable batteries and are typically large and heavy. Therefore, lead-acid batteries are unable to store a large amount of energy which can increase battery weight and practically limits their applicability in electric vehicles. The different components of a lead-acid battery are shown in Figure 10.3 [2].

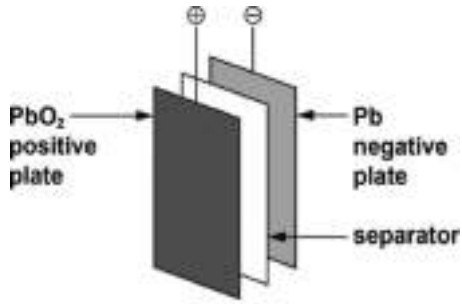


FIGURE 10.3 Chemistry and principal components of a lead-acid battery [2].

10.4 ALKALINE BATTERY

The alkaline electrolyte-based batteries were first developed in 1899 by Waldemar Jungner. Lewis Urry developed a button alkaline cell in 1949 and put it in the market by Ray-O-Vac Co, USA. In 1950, Lewis Urry invented zinc/manganese dioxide dry alkaline battery with high specific energy and relatively low cost. In 1957, Marsal, Larl and Urry filed a US patent (US2960558A) for the alkaline battery and granted it in 1960 [4]. Zinc alkaline batteries had leakage problems and decreased self-life in the late 1960s. To prevent the electrolytic action on impurity sites, a film of mercury amalgam was used on a zinc electrode [5]. A French company in the 1970s introduced a battery of better performance at a low cost with a new plastic-bonded negative electrode and sintered positive electrodes.

In the late 1980s, inspired by the increasing demand for high volumetric energy, Dr. Oshitani developed positive electrode foam technology which increased volumetric energy up to 30%. Mercury degrades the stability and purity of the electrode so the minimum use of mercury was required [6]. In 2005, after a century after the discovery of the Ni–Cd cell, Dr. Bernard et al. introduced a plastic-bonded positive electrode which exhibit high electrochemical performance at a lower cost using sintered electrode technologies. Modern alkaline batteries have manganese dioxide as a positive electrode and zinc negative one. This battery is called alkaline battery only because of an alkaline electrolyte used in it. Nickel-cobalt (Ni–Co) electrode materials give high capacitance, high abundance and good cycle stability [7]. Furthermore, nickel-based electrodes are redox active and good electrically conductive material for energy storage applications [7]. Moreover, the comparative studies between different types of batteries and commercially available nickel battery sizes are demonstrated in Tables 10.2 and 10.3, respectively.

10.4.1 Zinc Manganese Dioxide (Zn–MnO_2)

The zinc manganese dioxide (Zn–MnO_2) batteries are suitable for industrial applications where moderate amounts of electricity are needed. These batteries are commonly used worldwide in digital cameras, toys, flashlights, radios, compact disc players, etc. The low cost of material and high energy density application are other

TABLE 10.2
Comparative Studies between Different Types of Batteries

Types of Batteries	Cathode	Anode	Electrolyte
Alkaline	Manganese dioxide	Zinc	Aqueous alkaline
Lead acid	Lead dioxide	Lead	Sulfuric acid
Nickel	Nickel oxyhydroxide	Cadmium, hydrogen absorbing alloy	Potassium hydroxide
Lithiumion	Lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$) Lithium nickel cobalt aluminum ($LiNiCoAlO_2$)	Carbon-based typically graphite	Lithium salt in an organic salt

TABLE 10.3
Commercially Available Nickel Battery Sizes

Sizes	D	C	AA	AAA	Sub C	Nine Volts	Button
Diameter in mm	34.2	26.2	14.5	10.5	22.2	26.5	Varies in Ni–MH
Length in mm	61.5	50	50.5	44.5	42.9	48.5	Variable size exists

advantages of Zn–MnO_2 battery, which enhance the scientists interest in commercialization and engineering. In Zn–MnO_2 battery, the negative and positive electrodes are Zn and MnO_2, respectively. In the discharging process of Zn–MnO_2 battery, only electrode materials (Zn & MnO_2) take part in the reaction, as seen in the reaction below:

$$Zn + 2MnO_2 \rightleftharpoons ZnO + Mn_2O_3 \tag{10.4}$$

During the reaction, the alkaline electrolyte KOH remains in equal amount of OH^- based on the contents of zinc in the KOH electrolyte and purity of manganese dioxide used; the nominal voltage of Zn–MnO_2 battery is 1.5 V; however, it varies from 1.50 V to 1.65 V. The Zn–MnO_2 battery has varying voltages, 1.3 V to 1.1 V, which depend on the current drawn and load level of discharge. After fully discharge, battery of 1 V potential still remains.

Recently, Zhang et al. reported a high capacitive rechargeable Zn–MnO_2 battery system with a mild-acidic zinc triflate electrolyte. The aqueous zinc/manganese triflate electrolyte formed the protective porous MnO_2 layer. In Figure 10.4a, Zn–MnO_2 batteries delivered 10% capacity depth of discharge and lower cycle stability. Recently, the rechargeability of Zn–MnO_2 battery has been improved by using a mild zinc-based acidic electrolyte. Figure 10.4b shows the reversible extraction/insertion of Zn^{2+} ions in the layered structure. A significant improvement finds in the cycling stability of zinc manganese dioxide battery employing $Mn(CF_3SO_3)_2$ and

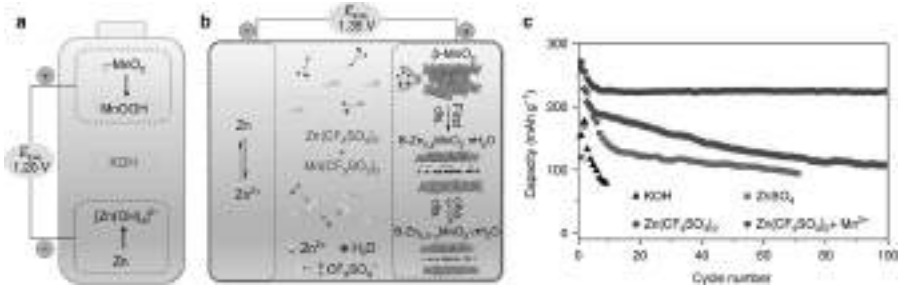


FIGURE 10.4 Zn–MnO_2 battery chemistry. Schematic illustration of (a) the primary alkaline Zn–MnO_2 battery using KOH electrolyte and (b) the rechargeable Zn–MnO_2 cell using CF_3SO_3-based electrolyte. (c) Comparison of the cycling performance of Zn–MnO_2 cells with electrolytes of 45 wt% KOH (at 0.32 C), 3 M $ZnSO_4$, 3 M $Zn(CF_3SO_3)_2$, and 3 M $Zn(CF_3SO_3)_2$ with 0.1 M $Mn(CF_3SO_3)_2$ additive at 0.65 C. nC equals the rate to charge/discharge the theoretical capacity (308 mA/hg) of MnO_2 in 1/n hours. (Reproduced from ref. [8] with permission from Springer Nature, © 2017.)

concentrated $Zn(CF_3SO_3)_2$ electrolyte which can be seen in Figure 10.4c. The cycle stability was found to be 94% after 2000 cycle with a high reversible capacity of 225 mA/h/g [8].

10.4.2 Nickel-Based Alkaline Batteries

With the growth of technology, the need for rechargeable batteries has increased manifold; lots of research studies are taking place to improve their efficiency so that they can be used in all types of electronic devices, vehicles, aeronautics industry, etc. In the last few years, the market has been commercialized in terms of hybridization topologies in order to increase the energy density and power density of the batteries. However, the electric double-layer capacitors and lead-acid batteries have solved many problems related to enhanced efficiency in terms of power and energy, longer life span, thermal stability. Still, the biggest challenge lies in the increased price as it is not cost-effective. In this context, nickel plays a significant role as it gives high energy density and better storage capacity at a very lower cost as compared with other batteries.

The nickel metal is the fifth most commonly found naturally occurring element on the earth surface. It has a silvery white shining appearance; it easily forms alloys because of its chemical properties. It has good catalytic and magnetic properties and can be easily recycled. From the mid-90s, its use is much more commercialized in battery technology and has a good market share. The most commonly used batteries like nickel cobalt aluminum use 80% nickel, whereas nickel manganese cobalt uses 33% nickel [9]. Most of the LIBs also rely on nickel. The nickel batteries are generally rechargeable and used in portable electronic devices, hybrid vehicles and stationary storage mechanisms. The main features include a discharge curve which is flat; it has a wide range of temperature operations. It is environmentally friendly as it can be easily recycled. Overall, it has a robust mechanism that is physically and chemically tolerant toward charging and discharging.

The nickel, along with manganese or aluminum, is used in LIBs to increase its longevity as well as proper capabilities. Also, nickel (tabs) strips are being made from ferromagnetic nickel alloy 201, which is highly conducting and noncorrosive in nature. Moreover, its resistance is also very low, making it viable to use as it is safe, heat resistant and there is no waste of energy. The nickel foam is used as it is porous with 75% to 95% void spaces, making it the perfect material to be used as a current collector due to its low density.

The nickel batteries consist of a cathode, anode and separator. The separator should be porous enough for the chemical reactions to take place. These three elements are mainly wound in Swiss roll or jelly roll type structure. At the top of this, the structure is a metal tab that connects the anode to a sealing plate, which seals the corrosive electrode and acts as a self-sealing vent that allows gases to escape if there is overcharging of the battery [10]. There are different types of nickel-based alkaline batteries, viz., nickel-iron (Ni–Fe) battery, nickel-zinc (Ni–Zn) battery, nickel-cadmium (Ni–Cd) battery and nickel-cadmium (Ni–Cd) battery. We have discussed in detail about these batteries in the following subsection.

10.4.2.1 Nickel–Iron (Ni–Fe) Batteries

Nickel-iron (Ni–Fe) batteries are rechargeable batteries and are much commercialized because they are much cheaper. It was the first commercialized nickel battery. The glory that adds to this battery is its long life and environmentally friendly. Nickel and iron as raw material are the most abundant material found on earth, which makes them cheaper [11]. It uses Fe as anode and Ni as cathode with KOH as an electrolyte. This is more resilient toward charging and discharging and maintaining its thermal stability and internal resistance [12]. Moreover, the energy density of nickel-iron batteries is in the range of 20–50 Wh/Kg, power density 65–90 W/Kg and cycle life 2000–5000 cycles. They have an excellent life cycle and are mainly used in locomotive applications, with the recent development of sintered electrodes where the nickel oxide cathode finds its applications in electric vehicles [13]. The main advantages of Ni–Fe battery are good resistance against vibrations. The operating life is long; hence, it is very much durable. It has good response toward charging and discharging of the battery. However, it is being observed that at low temperature its performance is very poor. Another setback is the rate of discharging as it is very high, nearly 40% every month. The specific energy is also very low, approximately 50 Wh/kg, which makes it less viable to get commercialized.

10.4.2.2 Nickel–Zinc (Ni–Zn) Battery

It is one of the rechargeable batteries which have good performance in high drain applications. As nickel and zinc are naturally occurring materials on the earth crusts, hence it is less expensive. The use of zinc electrodes has made it commercially competitive with other batteries existing in the market. This cell has got a voltage of 1.85 V in an open circuit when fully charged. A Ni–Zn battery has a similar curve in charging and discharging with a higher voltage (~1.7 V) as compared to Ni–Cd and Ni–MH batteries. It has got low internal resistance and high power density with excellent performance at low temperatures. Ni–Zn batteries use no toxic elements like Ni–Cd; hence, it is not a threat to our environment and can be easily recycled.

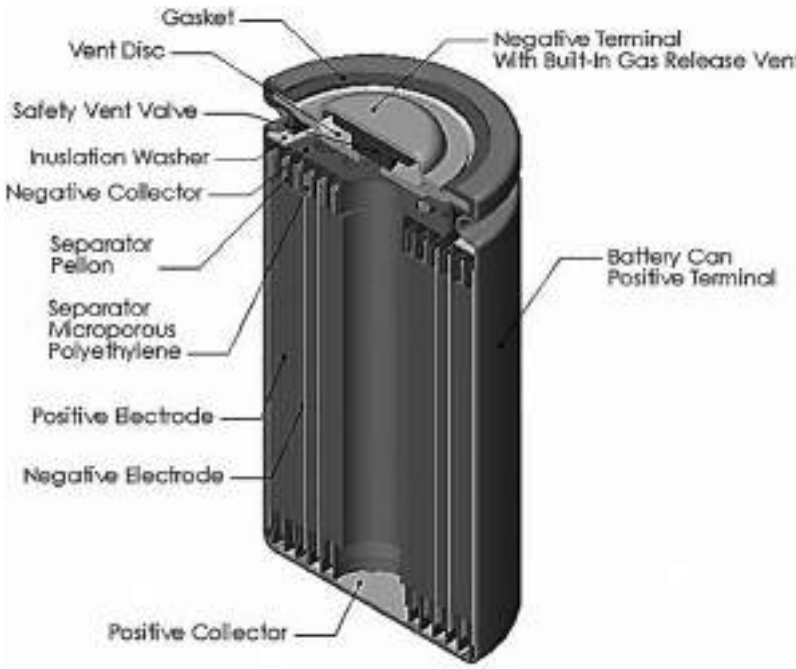


FIGURE 10.5 Internal structure of power Genix Ni–Zn Battery. (Reproduced from [15] with permission from IOP Publishing, © 2009.)

It is also inflammable as it uses on active materials, so it is safe to use [14,15]. Figure 10.5 demonstrates the internal structure of power Genix Ni–Zn battery [15].

In Ni–Zn batteries, nickel is also used as a positive electrode and zinc as a negative electrode. The chemical reaction at positive and negative electrodes is given in Equations (10.5) and (10.6), respectively.

$$2NiOOH + 2H_2O + 2e^- \rightarrow 2Ni(OH)_2 + 2OH^- \tag{10.5}$$

$$Zn + 2\ OH^- \rightarrow Zn + H_2O + 2e^- \tag{10.6}$$

Ni–Zn batteries are used for portable power, small-scale applications at high discharge rates. Ni–Zn batteries are relatively lower in cost than Li–ion batteries and can replace both Ni–Cd and Ni–MH batteries in most of the applications [6]. Ni–Zn batteries have high efficiency, high specific power and low cost. Both Ni and Zn can easily maintain their physical and chemical properties during cycling, and hence less effect on the environment. However, Zn is a self-corrosive material and soluble in KOH so Ni–Zn batteries show low discharge after a few cycles [16,17]. Although this battery was there for many years, the major challenges faced were the distribution of active materials on the electrode and the formation of dendrites during the charging and discharging process. Figure 10.6 shows the formation of dendrites in

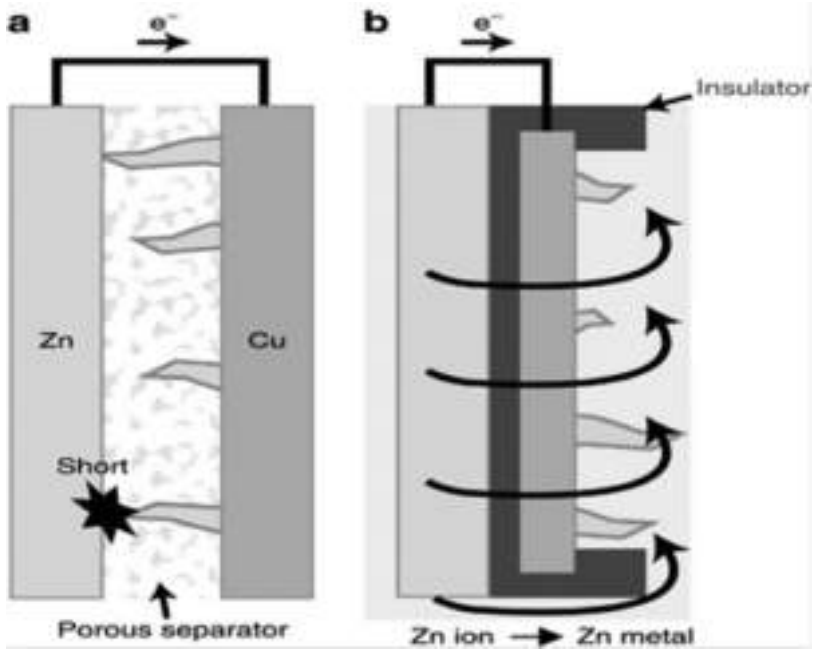


FIGURE 10.6 Formation of dendrites in Zn [18]. (Reproduced with permission from Nature, © 2016.)

TABLE 10.4
Features of Ni–Zn Battery

Energy Density (Wh/Kg)	Power Density (W/Kg)	Cycles Life Cycles	Anode	Cathode	Electrolyte
60–70	100–200	200–300	Nickel hydroxide	Zinc	Potassium hydroxide

Zn electrodes [18]. Table 10.4 demonstrates the important electrochemical properties of Ni–Zn battery.

The zinc electrode technology was based mainly on these principles, i.e., the requirement of good conductivity for the whole mass independent of the state of charge, a high level of porosity to be maintained at the anode of the cell, and treatment of soluble zincates were formed during the charging process. Moreover, to maintain the above principal and to other rectify the above-mentioned issues, a three-dimensional structure was made to support and collect current to reduce resistance and improve the electrical connections. The coating of a separator also helps in inhibiting the dendrite formations. Also, the copper foam was used to increase the porosity of the material at the zinc electrode, a composition of zinc oxide was mixed with additives like zinc alloys, conductive polymers having high adsorption capacity for zincates in order to trap zincates from the surface constituting a more conducting network and preventing dendrites formations. The use of calcium oxide

as an additive helps in forming calcium zincates, which are less soluble than normal zinc hydroxides. Pasted powder technology or the pressed powder method is used to fabricate zinc electrode, with a substrate material like foil, foam mainly made of copper. This substrate maintains stability when the cathode undergoes polarization. This method also helps in changing electrode shape.

The advantages of Ni–Zn battery are good cycle life in terms of charging and discharging, high capability rate of nearly 25 C, very fast recharging, and cheaper than benign materials, which can be cycled to 100%, nontoxic, inflammable and safe to use as it is environmentally friendly in nature. However, the shortcomings of Ni–Zn batteries include heavy and bulky structure, low-energy density, discharge rate is very high and formation of dendrites which reduces final efficiency.

Ni–Zn batteries are used in consumer batteries and power tools. It is an excellent substitution for Ni–Cd, lithium-ion and Ni–MH batteries in terms of energy density, toxicity and price. Ni–Zn batteries can be used in hybrid electric vehicle (HEV) which provides similar power density and energy density to drive HEV vehicles at half the price of lithium ion. Ni–Zn batteries are used in micro hybrid (start/stop vehicles). In microhybrid vehicles, when the vehicles stop, then the engine shuts down, resulting in more consumption of fuel. A Ni–Zn battery has high power, half weight and more charge acceptance as compared to lead-acid battery at a competitive cost. The Ni–Zn battery at the utility scale meets the requirement of high power in terms of regulated frequency and provides an effective backup power system. Military requires a high level of sophisticated power supply which would be safe and powerful for use. In this regard Ni–Zn battery fulfills the entire criterion. Hence, Ni–Zn provides an excellent balance of power and energy density in order to meet the potential requirement of applications in various devices and vehicles in terms of safety, cycle stability and cost-effectiveness.

10.4.2.3 Nickel-Cadmium Battery

It is a rechargeable battery which can be recharged many times, and it maintains constant potential when discharged. It gives hassle-free service and finds applications in digital cameras, calculators, photoflash equipment, recorders, etc. Ni–Cd cell is available in all shapes and sizes ranging from AAA to D with a potential difference between 1.25 V and 1.35 V [19]. The potential of the Ni–Cd battery is 1.2 V, which is lower than the alkaline zinc-carbon cell (1.5 V), so the Ni–Cd battery cannot replace in all applications. However, many electronic appliances work at low voltages (0.90 V to 1.0 V per cell); the relatively steady 1.2 V of a Ni–Cd cell is enough to allow operation [20]. The battery is used safely in the temperature range from –20°C to 45°C. During charging, the battery temperature is around the same as the ambient temperature, but as the battery gets fully charged, the temperature will rise to 45°C–50°C. These batteries are capable of rapidly recharging to hundreds of instances and are tolerant including overcharging. However, compared to other batteries and even lead-acid batteries, nickel-cadmium batteries have limited power density and are also heavy in weight. They perform better if fully discharged every cycle before recharge. In any other case, cells may also exhibit a memory effect. Alkaline batteries show some application in backup power systems where low-temperature conditions, very high currents and high reliability are unique elements.

Large nickel-cadmium batteries are used to start aircraft engines and in emergency power structures. In addition, they are used in conjunction with solar-powered contemporary supplies to provide electrical power at night. Although they have some good characteristics, it has some drawbacks that nickel and cadmium both are toxic heavy metals that may cause health risk. Ni–Cd battery could not get commercial success because of its high cost (about USD 1000 kWh) which is ten times higher than lead-acid batteries.

Nickel-cadmium (Ni–Cd) structures are the most common small rechargeable battery for portable gadgets. Sealed cells are equipped with "jelly roll" electrodes, which deliver the high current. The Ni-Cd battery contains a cadmium negative electrode, a nickel (III) oxide-hydroxide positive plate and potassium hydroxide as an alkaline electrolyte. The chemical reactions during charging, discharging and overall are given in Equations (10.7)–(10.9), respectively.

$$2NiOOH + 2H_2O + 2e^- \rightarrow 2Ni(OH)_2 + 2OH^- \tag{10.7}$$

$$Cd + OH^- \rightarrow 2Cd(OH)_2 + 2e^- \tag{10.8}$$

$$2NiOOH + Cd + 2H_2O \rightarrow 2Ni(OH)_2 + Cd(OH)_2 \tag{10.9}$$

When the battery is discharged, then the cathode contains nickel hydroxide and the anode has cadmium hydroxide, whereas when the battery is charged, then reverse action takes place at anode, cadmium hydroxide changes into cadmium and at cathode nickel hydroxide changes into nickel. The electrolyte used is alkaline potassium hydroxide and a separator is also used.

This battery has metal cases with a safety valve; the anode and cathode isolated by the separator are rolled in the form of a jelly roll design or in a spiral shape. This design helps the battery to deliver maximum current comparable to an alkaline battery. Traditionally, Ni–Cd batteries were available in sealed types, where the release of gas occurs when it is overcharged. Vented cells have a low-pressure valve that generates oxygen and hydrogen when it undergoes a cycle of charging and discharging. This structure makes the battery safer, lighter and economical for use. Vented Ni–Cd batteries can operate for a wide range of temperature and has long life.

Ni–Cd batteries have a number of advantages as compared to other batteries available in market. It works extremely well in every robust condition and has long-term storage when fully discharged. As compared to other lead-acid batteries, Ni–Cd battery has got a high energy density and longer life in terms of charging and discharging. When compared to alkaline batteries, it has reversible chemical reactions which make them reusable and long-lasting. When compared to Ni–MH and lithium-ion batteries, this battery is much cheaper and has a lower self-discharge rate. Hence, it can be seen that Ni–Cd is a good choice for applications in photography and other portable devices as it has good specific energy and pulse power performance, and at the same time, it is relatively inexpensive as compared with other batteries

However, the disadvantages of Ni–Cd battery include as it is much costlier than lead-acid battery because cadmium and nickel cost more. The biggest threat is environmental hazards as cadmium is very toxic in nature. Under the battery directives,

TABLE 10.5
Characteristics of Ni–Cd Battery

Energy Density (Wh/L)	Specific Energy (Wh/Kg)	Specific Power (W/Kg)	Cycle Durability Cycles	Self-Discharge Rate	Nominal Voltage	Charge/Discharge Efficiency
50–150	40–60	150	2000	10% month	1.2 V	70%–90%

this battery has been banned in many countries. Recycling of this battery is also the biggest problem. It has the problem of thermal runaway in which the current keeps on rising until the battery destroys itself. It also exhibits a negative temperature resistance in which the internal resistance decreases as the temperature increases. Memory effect is another issue related to its charging; in this effect, it is seen that the battery retains the characteristics of previous charging and gives the false impression of charging. In Table 10.5, the range of various parameters of Ni–Cd battery has been shown. It has been observed that the range of cyclic durability is nearly 2000 cycles and charge/discharge efficiency is nearly 70% to 90%.

10.4.2.4 Nickel-Metal Hydride (N–MH) Battery

It's always a good choice to use rechargeable battery packs containing lithium ions cells as it gives excellent high energy density, storage and high voltage, for many applications such as mobiles, bio-medical instruments, electric hybrid vehicles, etc. Customized nickel-metal hydride is a very good substitute, as it is cost-effective in manufacturing and has no potential hazards linked with lithium products. The technology of Ni–MH batteries is not new as it was available in the early 70s, but when compared with Ni–Cd and lead-acid batteries, it is environmentally friendly and has excellent cycle life, with good safety and reliability performance. Moreover, it does not require the complexity of battery management technology like lithium batteries, still satisfying the customer need as lithium pack [21, 22].

Ni–MH has a positive electrode of nickel hydroxide and a negative electrode is interstitial hydrogen in the form of a metal hydride; the electrolyte used here is alkaline potassium hydroxide. In Ni–MH, the "*M"* represents intermetallic compound as a negative electrode; this "*M"* is of the formula AB_5, where "*A"* is a rare earth element (mainly used are cerium, lanthanum, neodymium, praseodymium), whereas "*B"* side comprises of cobalt, nickel, aluminum or manganese. In some cells, the negative electrode "*M"* has the formula AB_2; here, *A* is generally vanadium or titanium, whereas *B* is either zirconium or nickel.

Nickel-metal hydride (Ni–MH) batteries are replacing nickel-cadmium batteries in many applications because of the absence of toxic cadmium and have two–three times higher capacity than Ni-–Cd battery per unit volume. The chemical reaction on the positive electrode is similar to Ni–Cd battery, whereas at the negative electrode, hydrogen absorbing alloy is used instead of Cd. The charging and discharging voltage of Ni–MH battery is 1.6 V and 1.25 V, respectively.

Ni–MH has higher self-discharge, lower efficiency and costly as compared with lead-acid and nickel-cadmium batteries. The cost rises mainly over the constraints

TABLE 10.6
Comparison of Ni–MH with Li–ion Battery

Cell Type	Cell Voltage (V)	Specific Energy (Wh/Kg)	Specific Power (W/Kg)	a. Energy Density (kWh/m^3)	Power Density (MW/m^3)	Efficiency	Cost	Size
Li–Ion	3.6	3–100	100–1000	80–200	0.4–2	99	Costly	Small and lighter
Ni–MH	1.2	1–80	<200	70–100	1.5–4	81	Less costly	

on the manufacturing process and safe disposal because of the concerns on cadmium toxicity. It has been labeled "Eco friendly". It has a profitable margin when recycling is done. Lithium ion has the major problem of "Thermal Runaway"; this battery has a better design for this, but as compared to Ni–Cd, it is not that effective in solving the problem of thermal runaway. The chemistry of Ni–MH and Ni–Cd is moreover the same because of the same design; Ni–MH has a capacity of 30% more than Ni–Cd batteries but less in memory. As compared to others, this requires high maintenance as crystalline formation takes place if a full discharge is not done regularly. In Table 10.6, a comparative study of Ni–MH versus Li–ion battery has been given. Li–ion battery is more efficient and lighter than Ni–MH, but it is costlier. The comparative study of Ni–MH and alkaline battery has been shown in Table 10.7; it has been shown that the performance of Ni–MH is much better than alkaline batteries.

It is very convenient to store and its transportation is easy because it is not governed by any regulatory controls. However, it should be stored in a cool place as performance gets degraded at high temperatures. When compared with a primary battery, it has greater advantage as it can work at extreme low temperatures of about –20°C. It operates well over a wide range of temperatures, i.e., 0° to 50° and life expectancy is also more. It can be recharged as many times as possible and shows efficiency even at a high rate of self-discharge. It has 50% of self-discharge when compared to Ni–Cd batteries. It has a critical trickle charge and generates heat while charging; it also takes longer time to get charged as compared to Ni–Cd batteries. Ni–MH has 50% less final battery pack production price than a lithium battery, and it is less than 75% of a lithium battery in terms of the development of the product.

The chemical reactions at negative and positive electrodes are given in Equations (10.10) and (10.11), respectively.

$$H_2O + M + e^- \rightleftharpoons OH^- + MH \tag{10.10}$$

$$Ni(OH)_2 + OH^- \rightleftharpoons NiO(OH) + H_2O + e^- \tag{10.11}$$

Ni–MH battery has a higher self-discharge rate as compared to Ni–Cd battery, which varies greatly with temperature, i.e., is 5%–20% on the first day and stabilizes around 0.5%–4% per day at room temperature. The cylindrical structure of Ni–MH battery is shown in Figure 10.7 with a cap positive electrode, negative electrode and separator [21].

TABLE 10.7
Comparison of Ni–MH Battery with Alkaline Battery

Application Features	Voltage	Discharge Capacity	Recharge Capability	Discharge Voltage Profile	Self-discharge Rate	Low Temperature Performance	Weight	Environmental Issues
Ni–MH	1.25 V	Lasts longer	Several hundred cycles	Flat	50%–80 % @ 12 months	Better than alkaline	Less lighter	Recycling can be done. Environmentally friendly
Alkaline	1.5 V	Less	NA	Sloped	Retains 80% @ 10 years		Lighter	Less options available

FIGURE 10.7 Nickel-cadmium batteries [21].

In order to have a hassle-free use of Ni–MH battery in terms of its maintenance and performance, basic knowledge of charging is very important as overcharging may damage the battery, which will result in loss of its capacity. Overcharging results in the formations of small crystals on the electrodes thus inhibiting the charging process. It is observed that the charging of Ni–MH is more complicated as compared to Ni–Cd battery. Designing of a charger is very important as in Ni–Cd a distinct bump is seen in output voltage when it is fully charged, but in Ni–MH, this bump is very small and difficult to detect. The charging efficiency of all forms of nickel-based batteries is about 70% of the full charge; initially, the temperature rise is less, but as the charge level increases, the efficiency level drops, thus raising the temperature of the battery [23,24]. Figure 10.8 shows the internal structure of the Ni–MH battery with a special reference to the separator and electrodes [23].

There are various methods for the charger to have constant current like timer charging by using an electronic timer which will help from getting overcharged; thermal detection from getting overheated; and negative delta voltage detection to detect the drop in voltage; compared to all, the step differential method is preferably used in advanced Ni–MH chargers in which initially fast charging of 1C is done followed by a cooling period, later the charge cycle is completed. In this process, the charger further applies reductions in current as the charging progresses.

Nickel-metal hydride (Ni–MH) batteries generally have self-discharge of 1% per day when they are used in a low-energy consummation mode or in a stand-by device, which affects their memory. Manufacturers are using BMS technology which is cost-effective in order to develop a system, which will trickle charges to reduce the negative effects of overcharging and to attain its maximum capacity. Mostly, a smart charger is used with a moderate rate of charging up to 2 hours to 3 hours.

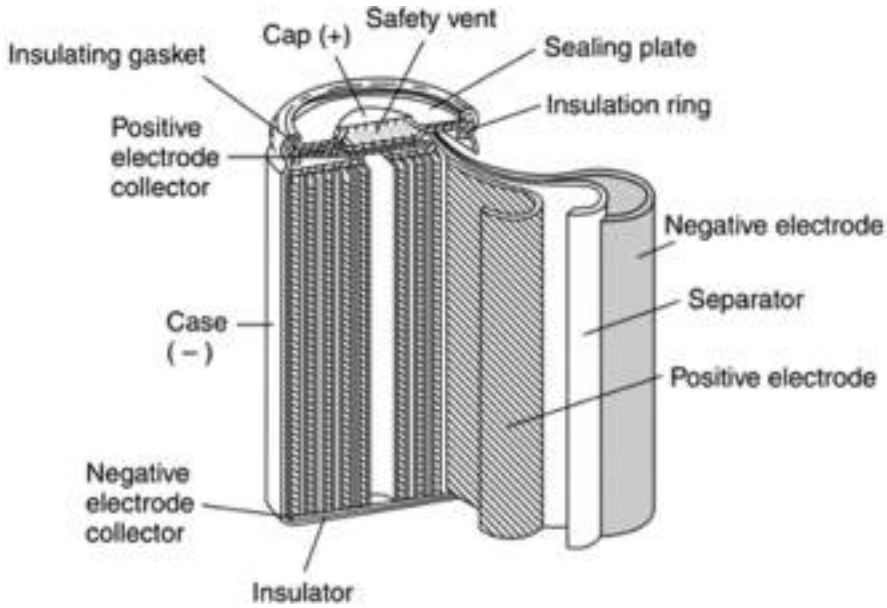


FIGURE 10.8 Structure of cylindrical Ni–MH battery [23]. (Reproduced from ref. [23] with permission from Elsevier, © 2001.)

The gases which are emitted due to overcharging are hydrogen and oxygen, so the battery enclosures of Ni–MH should be airtight and properly vented. Moreover, isolating the battery from the components which generate heat will also reduce the thermal stress. Figure 10.9 shows the charging and discharging of the battery in terms of the chemical reactions that take place inside the battery [25].

10.4.3 Nickel-Hydrogen (Ni–H_2) Battery

The nickel-hydrogen (Ni–H_2) battery was first patented in 1971 by Alexander et al. in US [26]. Ni–H_2 battery is a rechargeable power source based on nickel and hydrogen; here, hydrogen is used as fuel with conventional nickel electrode. Ni–H_2 is used in over 800 satellites with good reliability. The overall reaction of the cell is given in Equation (10.12).

$$2NiOOH + H_2 \rightleftharpoons 2Ni(OH)_2 \tag{10.12}$$

It can be observed by the reaction that nickel hydroxide is formed at the positive electrode and hydrogen is produced at the negative electrode. Ni–H_2 battery can handle up to ~20,000 charge cycles with 85% efficiency. Ni–H_2 battery using KOH as an electrolyte performed an energy density of 75 Wh/kg and a specific power of 220 W/Kg. Ni–H_2 battery has a discharge voltage of 1.25 V. In the recent few years, nickel-metal hydride batteries have been used in several commercial hybrid vehicles such as Toyota Prius and Honda Insight. Nickel electrode-based batteries are compared in Table 10.8.

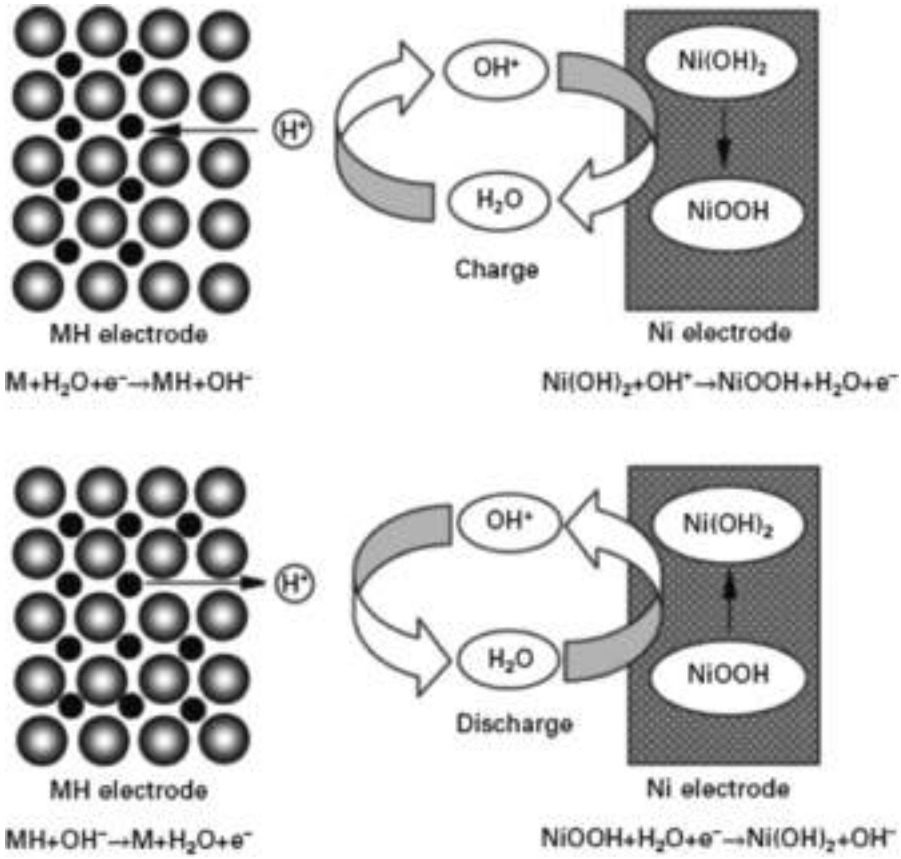


FIGURE 10.9 The charging–discharging process of the hydrogen atom dissociates from $Ni(OH)_2$ and is absorbed by the MH alloy and the hydrogen atom dissociates from the MH alloy and joins with NiOH to form $Ni(OH)_2$ [25]. (Reproduced from ref. [25] with permission from Elsevier, © 2001.)

TABLE 10.8
Nickel-based Batteries Comparative Parameter

Battery	Cell Voltage (V)	Specific Energy (Wh/kg)	Specific Power (W/kg)	Energy Efficiency (%)	Cycle Life
Nickel-Cadmium	1.2	50–60	200	70–75	>1500
Nickel–Iron	1.2	30–60	100	60–70	1500
Nickel–Metal Hydride	1.2	60–70	170–1000	70–80	>1000
Nickel–Zinc	1.2	80–100	170–1000	70–80	<500

10.4.4 Advantages of Alkaline Battery

The performance of an alkaline battery is good at low and ambient temperatures. These have a high energy density, a fairly long self-life, low internal resistance, better dimensional stability and very less leakage problem. Alkaline batteries perform equally well in both intermittent and continuous use. These are also well-performing high and low rates of discharge. An alkaline battery has a fairly long self-life. Moreover, alkaline batteries have drawbacks. Alkaline batteries are bulky as compared to lead-acid battery. Alkaline batteries have high internal resistance which reduces the output power. Alkaline batteries have different types of leakage from other batteries or cells; they can leak if left in the appliance for too long, and this corrosive leak can damage a device. However, with these disadvantages in mind, alkaline batteries are still an excellent choice for many uses, including developing a battery pack.

10.5 SODIUM-ION BATTERIES

The commercialization of different types of batteries in the market has given the option to search for new materials for electrode, which will fulfill all the criterion prerequisites for high efficiency of the batteries. In this context, sodium-ion batteries have received great attention due to its versatile features like better safety, good power delivery and it can be used for many purposes. The main advantage of this battery is a huge natural resource of sodium being available. The principle on which LIBs and sodium-ion battery works is almost the same; instead of Li^+ ion, Na^+ ion is used for charging and discharging process through intercalation and deintercalation mechanism. The lower tap density, lower cost, elevated operating potentials and high capacities have attracted lot of attention for cathode-based sodium transition-metal oxides. This battery uses electrolytes that are aqueous as well as nonaqueous like dimethyl carbonate, diethyl carbonate, propylene carbonate, etc. It can be used for electric vehicles and other power tools if the energy density is increased [27]. Figure 10.10 shows the use of electrolytes and binders for sodium-ion battery; in the figure, the layered oxide is seen at the cathode and metal oxides at anode. Table 10.9 shows the comparative study of sodium-ion battery with lead-acid battery and LIB. In terms of efficiency, sodium-ion battery is much more efficient as compared to the other two.

The cathode of sodium ion stores charges through the reaction mechanism. The advantages of sodium-ion battery over other batteries are their low costs and corrosion-free reactions. It is durable, and it does not get damaged if it is charged for a long time. It has got excellent power delivery with less energy density. From performance wise, it is not applicable to portable electric vehicles and electronic devices. As it is three times heavier than lithium, hence it is not lighter and when used with organic solvents; it is not at all safe as it may cause fire. Figure 10.11 shows the working potential versus a specific capacity of the various materials at anode and cathode. The use of various electrolytes and binders has also been shown in the diagram for sodium-ion battery.

The two-dimensional layer of transition-metal oxides is based on the stacking sequence of metal oxide between the layers. The arrangement is made by

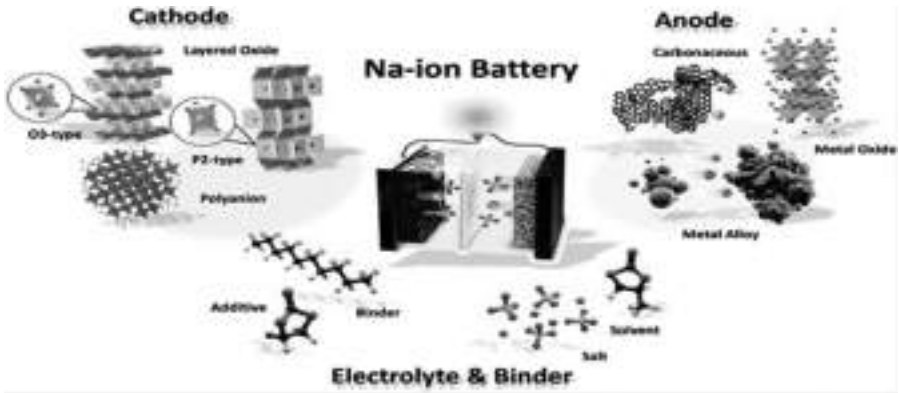


FIGURE 10.10 Cross section of sodium-ion battery [27]. (Reproduced with permission from Royal Society of Chemistry, © 2017.)

TABLE 10.9
Comparison of Sodium-ion Battery with Lead Acid Battery and Lithium-ion Battery

Battery Types	Lead Acid	Lithium-ion	Sodium-ion
Volumetric energy density (Wh/L)	80–90	200–683	250–375
Gravimetric energy density (Wh/Kg)	35–40	120–260	75–150
Cyclic stability	Moderate	High	High
Efficiency	70%–90%	85%–95%	Up to 92%
Range of temperature	–20°C–60°C	15°C–35°C	–20°C–60°C
Availability of resources	Availability limited	Not easily available scarce	Available in abundance
Safety	Moderate as it is toxic	Low	It is very safe to use
Price	Economical	Costly	Economical

sandwiching sodium ion layers between octahedral or prismatic structures. Based on the phase transition of the O_3 type and P_2 type, there is a structure variation, and at low temperature, the synthesis of these compounds takes place, breaking the M–O bonds through thermal analysis. There are lots of possibilities for upgrading the electrodes utilizing the sodiated anode material along with transition-metal oxides. In this, the two- or three-dimensional layer also uses fluorides for better efficiency of the electrodes. Polyanion materials have shown considerable thermal stability due to the covalent bonds in the deeply charged oxide state. For Sodium-ion batteries (SIBs), depending upon insertion reaction, Ti-based oxides as well as carbonaceous oxides are being used as anode material. Carbon materials, especially hard carbons,

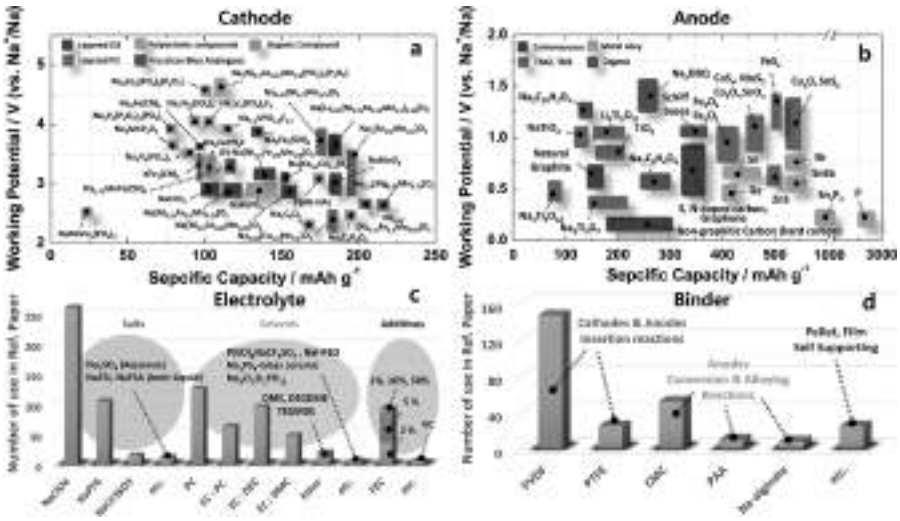


FIGURE 10.11 Working potential for Na-ion battery [27]. (Reproduced with permission from Royal Society of Chemistry, © 2017.)

are widely used because they have the potential to accommodate the sodium ions in its structure. They have a low operating potential. Companies of different countries depend a lot on many parameters such as types of electrodes used, with different manufacturing techniques. In Table 10.10, a comparative study has been made based on the companies of different countries.

The sodium-ion batteries have received lots of attention due to their abundance availability; SIB cathode material consists of metal oxide, metal sulfides, compounds of oxoanionic, polymers, Prussian blue analogue, etc. Lots of research are still in progress in order to make this battery more commercialized. Tables 10.11 and 10.12 summarize the advancements in anode and cathode material for sodium-ion batteries, respectively.

10.6 MG-ION BATTERY (MIB)

For the next-generation electrochemical power sources, large-scale portable and stationary electrical device applications, in addition to the LIB, the secondary MIB is one of the most hopeful alternative solutions. The MIBs have safer, richer abundances than LIBs. The magnesium metal has diverse characteristics with high natural abundance (approximately 10^4 times that of lithium, which helps to reduce the cost of electrode material). It is further incorporated into low-cost energy storage devices. The magnesium metal is more environmentally stable in nature, excellent thermodynamic properties, high volumetric capacity (3833 mA/h/cm^3), dendrite-free deposition, higher melting point than lithium, low reduction potential up to –2.4 vs. SHE, high Columbic efficiency, etc. [45,46]. Such remarkable inherent characteristics of Mg metal prove that the Mg metal is an ideal and promising electrode for MIBs. In addition, compared to nickel-cadmium and lead-acid batteries, MIBs

TABLE 10.10
Comparative Studies between Different Types of Batteries

Company Name	Country	Electrode	Characteristics	Uses
Faradion limited	United Kingdom 2011	Cathodes–oxides Anode–carbon and liquid electrolyte	Carbothermal reduction method of synthesis is used for electrode of $Na_3M_2(PO_4)_2F_3$	It is used in E–bike and E–Scooter
Tiamat	France 2017	Polyanionic	Cylindrical cells	Mainly used in power market
Hi–Na battery technology Co. Ltd.	China 2017	Cathodes of Na–Fe–Mn–Cu-based oxide Anode is of carbon	Energy density of 120 Wh/Kg	Used as a power bank
Natron	Stanford University, United States	Prussian blue electrode with an aqueous electrolyte	—	—
Altris AB	Uppsala University, Sweden 2017	Iron-based Prussian and carbon as an electrode	Low-energy process	Stationary energy storage
CATL Co. Ltd.	China 2021	Porous carbon as cathode and Prussian blue as anode	Specific energy density 160 Wh/Kg. Sodium ion has more volume and stable with structure	Electric vehicles and stationary storage battery

provide a significantly higher energy density. Also, in contrast to lead and cadmium, magnesium and lithium are less expensive and environmentally friendly in nature. The use of Mg metal as electrode material in MIBs reduces the final cost of battery and results in a more stable alternating power source than LIBs.

Nevertheless, the development of the magnesium-ion battery technology is not as fast as LIBs. This is because there are certain challenges among the development of magnesium-based cathode material for batteries. This includes high reversible capacity, high operating voltage, and nonavailability of appropriate electrolyte, which can allow the reversible release of Mg^{2+} ions from a Mg metal anode [47–50]. The sluggish nature of Mg^{2+} ions in solid electrolytes makes large voltage hysteresis and low magnetization degrees for most of the material [50]. Most of the electrolyte used in MIBs allows the development of passivating surface films, which impede the electrochemical performance during the charging–discharging process [46,51,52]. Another important problem associated with MIBs is the unavailability of a suitable electrolyte. The electrolyte which can neither accept nor donate proton can be the most suitable electrolyte for MIBs [46]. The second most significant difficulty in the development of MIBs is the limited choice of cathode material by the inability to intercalate Mg ions in many hosts [48]. To enlighten the structures and chemistries of the materials developed for magnesium-ion cathodes, in this section, we discuss the

TABLE 10.11
Recent Research Advancements in Anode Material for Sodium-ion Battery

S. No.	Anode Material	Charge Storage Mechanism	Potential	Initial Reversible Capacity	Current Density (mA/g)	Capacity After Cycle	References
1	Carbon microspheres	Intercalation and pore filling	0.005–3	202 at 30 mA/g	30	183 @50	[28]
2	3D porous Fe_3O_4–C	Conversion reaction	0.005–3.0	321 at 50 mA/g	100	277 @200	[29]
3	*N*-doped expended graphite	Intercalation	0.01–3.00	373.37 at 100 mA/g	1000	200 @1000	[30]
4	Mo–S_2 Carbon fiber	Conversion and interaction mechanism	0–3	529 @200 mA/h	50	452 @50	[31]
5	Amorphous Carbon	Adsorption at defect sits and	–0.01–2	284 at 100 mA/g	30	266.96 @100	[32]
6	MnO_2–Nanaoflowers	Conversion reaction and some extant of sodium	0.01–3.0	349.0 at 50 mA/g	50	177.1 @100	[33]
7	MoS_2–C	Conversion reaction	0.01–2.5	510 at 100 mA/g	100	390 @100	[34]
8	Graphene nanosheets	Adsorption and interlayer intercalation	0.01–2	220 at 30 mA/g	100	~176 @300	[35]
9	Se_4P_4	Conversion alloying mechanism	0.01–3	1048 at 50 mA/g	50	904 @60	[36]
10	Disodium terephthalate	Intercalation and redox	0–2	295 at 30 mA/g	30	265 @90	[37]

TABLE 10.12
Recent Research Advancements in Cathode Material for Sodium-ion Battery

S. No.	Cathode Materials	Voltage Range	Current Density (mA/g)	Initial Reversible Capacity	Capacity After Cycles	References
1	P_3–$Na_{0.9}Ni_{0.5}Mn_{0.5}O_2$	1.5–4.5	100	141 at 10 mA/g	79 @100	[38]
2	O_3–$Na_{1.0}Mn_{1/3}Fe_{1/3}$ $Cu_{1/6}Mg_{1/6}O_2$	2.3–3.6	20	135 at 10 mA/g	108 @100	[39]
3	Sodium copper hexacyanoferrate	2–4.2	50	89 at 50 mA/g	71.7 @1000	[40]
4	P_3–$Na_{2/3}Ni_{1/4}Mg_{1/12}Mn_{2/3}O_2$	0–3.5	133	125 at 133 mA/g	97.5 @100	[41]
5	$Na_4Fe_3(PO_4)_2P_2O_7$/C	2.04–2.22	1000	128.5 at 20 mA/g	71.6 @4000	[42]
6	O_3–$NaCrO_2$	1.5–4.2	200	123 at 10 mA/g	94 @500	[43]
7	$Na_4MnV(PO_4)_3$/C/GA	3.3–3.4	550	109.8 at 55 mA/g	87.7 @500	[44]

summary of the recent progress of cathode material and electrolyte for MIBs with special emphasis on strategies for future research initiatives. To solve these issues, in recent years, several strategies have been reported in literature; this includes the use of mesoporous and high specific surface area nanostructured material with high divalent ion mobility as cathode for MIBs [53,54]. The cathode fabricated from such material decreases the diffusion length for Mg ion into the cathode during the charging–discharging process [55–57].

10.6.1 Cathode Material for MIBs

Till date, Chevrel phase oxides, chalcogenides, carbon-based nanomaterials and polyanions have been investigated as a potential cathode material for MIBs. The mostly used cathode material for MIBs includes the Chevrel phase molybdenum sulfide (Mo_6S_8) [58], molybdenum disulfide (MoS_2) [59], orthorhombic molybdenum oxide MoO_3 [60,61], vanadium bronze (V_3O_8) [62], vanadium pentoxide (V_2O_5) [63], magnesiated vanadium pentoxide ($Mg_xV_2O_5$) [64], nickel hexacyanoferrate ($NiFe(CN)_6$) [65], copper hexacyanoferrate ($CuFe(CN)_6$) [66], and various manganese-based oxides such as hollandite MnO_3 [67], todorokite MnO_3 [68], birnessiteMnO_3 [67], Mg_6MnO_8 [69], manganese silicate ($Mg_{1.03}Mn_{0.97}SiO_4$) [70], iron silicate ($MgFeSiO_4$) [71], cobalt silicate($MgCoSiO_4$) [72], etc.

Considering the sluggish nature and unsatisfactory cycling life of cathode material used in MIBs, recently, various strategies and structural modifications, viz., mesoporous, hierarchical two- and three-dimensional materials as cathode for MIBs have been implemented. Chevrel-phase Mo_6S_8 is one of the important materials which is facilitated by the high mobility and fast interfacial charge transfer. Nowadays, Mo_6S_8 has gained considerable attention toward the application of cathode material at room in MIBs. Mo_6S_8 has superb intercalation kinetics and best reversibility. Also, at potential 1.2 V, the initial capacity for Mo_6S_8 is reported in literature to be up to 120 mA/hg [73,74]. To study the effect of leaching chemistry on the performance of Mo_6S_8-based cathodes of MIBs, Lancy et al. have reported interesting results: as they accommodate two Mg atoms per formula unit when $Cu_2Mo_6S_8$ leached in I_2/AN (acetonitrile) or in HCl/H_2O. Also, the capacity fading of the MIBs is reported because of the inability to extract Mg ions during charging at room temperature. The $Cu_2Mo_6S_8$ cathode in MIBs resulted in a specific capacitance of 90–100 mA/hg with excellent stability over large numbers of charge–discharge cycles [75]. Further, Choi et al. modify Mo_6S_8 by Cu metal and reported the increase in rate capability discharge of (99.1 mA/hg) than pristine with (85.6 mA/hg) at 1.0 V vs. Mg/Mg^{2+}. Moreover, in this study, the in-situ formation of $Cu_xMo_6S_8$ is studied further. Also, the electrochemical insertion of Cu from Cu nanoparticle/graphene composite to the Mo_6S_8 host and the schematic of Mg^{2+} insertion and extraction during the replacement reaction of Cu in the Mo_6S_8 is demonstrated in Figure 10.12 [76].

Wu et al. demonstrated the use of Lattice engineering to settle the issue of sluggish kinetics, which is one of the important reasons for dissatisfactory Mg-storage capabilities in two-dimensional layered materials. For this study, using heterogeneous monolayers of MoS_2 and graphene, they have fabricated the van der Waals' heterostructures. Further, they reported that the Mg-diffusion barrier was reduced

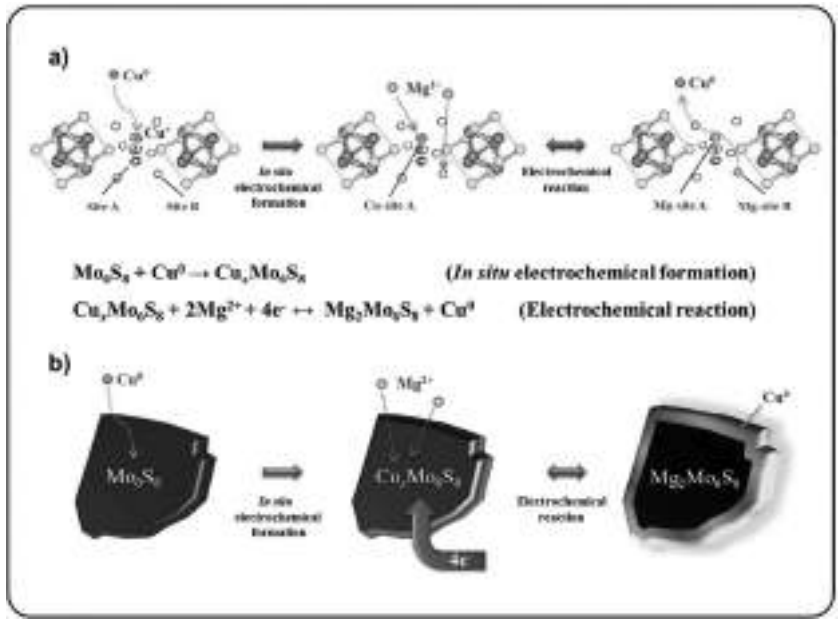


FIGURE 10.12 Schematics of (a) Cu replacement reaction in the Mo_6S_8 and (b) the proposed solid-state Cu replacement reaction structure during Mg^{2+} insertion and extraction. (Reproduced with permission with ACS, publication [76]. (Reproduced with permission from ACS Publication, © 2017.)

by 0.4 eV, and in consequence, the diffusion rate enhances 11 times higher than the diffusion rate of original MoS_2. As a result of the assisted diffusion kinetics, the Mg-storage capacity for MoS_2/GR and its rate performance are reported to be 210 mA/hg and 90 mA/hg at 500 mA/g, respectively [77]. To enhance the electrochemical performance and enhances the Mg-ion kineticsm, Liu et al. synthesized and studied the MoS_2/graphene hybrid material as cathode for MIBs. The facile lithium-assisted sonication method was used for the synthesis of cathode material. In this study, graphene is inserted in MoS_2, this influences the Mg^{2+}-ion insertion–deinsertion in the host MoS_2/graphene hybrid cathode, as a result, the electrochemical behavior of MoS_2/graphene hybrid cathode in MIBs enhances. The initial capacity and cyclability after 50 cycles for MoS_2/graphene cathode are reported to be 115.9 mA/hg and 82.5 mA/hg, respectively. Furthermore, the cyclic voltammetry curves at various scan rates, typical GCD profiles at various current densities and electrochemical impedance spectra of different MoS_2/graphene-15 composites are demonstrated in Figure 10.13 [78]. The reported MoS_2/graphene-15 hybrid fascicled MIBs demonstrated excellent electrochemical behavior as compared to bare MoS_2 or graphene [78]. Furthermore, the issues related to Mg-ion adsorption at host material and diffusion, Yang et al., using the Density Functional Theory, investigated the MoS_2 nanoribbon as cathode material for MIBs and reported the maximum theoretical of 223.2 mA/hg [79].

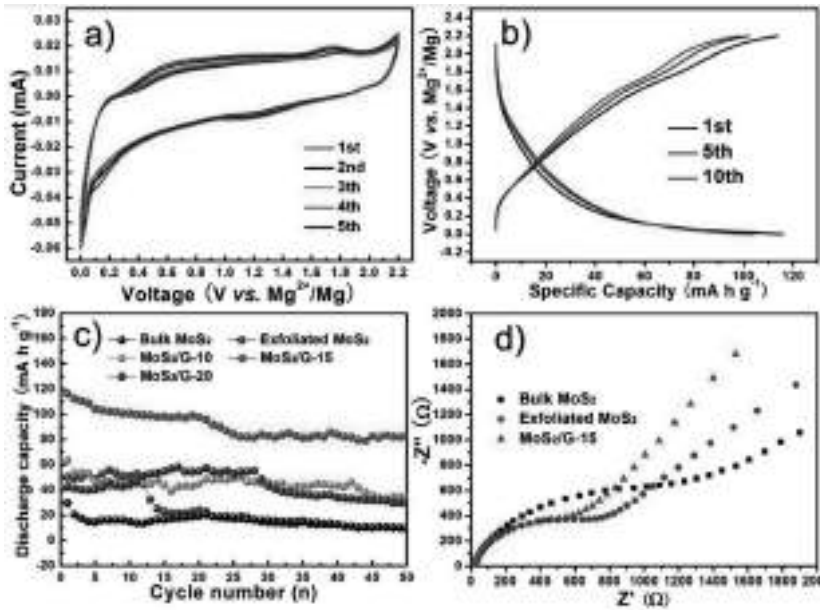


FIGURE 10.13 (a) The cyclic voltammetry curves of MoS_2/graphene-15 electrode scanned at a rate of 0.5 mV/s in the voltage window of 0 V–2.2 V vs. Mg^{2+}/Mg. (b) Typical GCD profiles of MoS_2/graphene at a current density of 20 mA/g. (c) Cycling performance of bulk MoS_2, exfoliated MoS_2, and the MoS_2/graphene-15 composites at 20 mA/g. (d) Electrochemical impedance spectra of bulk MoS_2, exfoliated MoS_2, and MoS_2/graphene-15 electrodes [78]. (Reproduced with permission from Elsevier, © 2017.)

10.6.2 Transition-Based Cathode Material for MIBs

In recent years, over the transition-metal sulfide, transition-metal oxides have gained enormous attention as the cathode material for MIBs. Owing to the many attractive properties such as good electrochemical characteristics, higher working potentials, better thermal stability etc., transition-metal oxides reported to be superior cathode material than the transition-metal sulfide for MIBs. Many transition-metal oxides such as MnO_2 [80], V_2O_5 [81], $VOPO_4$ [82], TiO_2 [83], etc. also offers the similar advantages. Zhang et al. [84] reported the nano-sized hollandite phase α-MnO_2 cathode material for MIBs. The reported cathode material demonstrated excellent electrochemical performance in electrolyte Mg_2 $(\mu\text{-}Cl)_3{\cdot}_6(OC_4H_8)((N(Si(CH_3)_3)_2)_nAlCl_{4-n})$ ($n=1$, 2) with a specific capacitance of 280 mA/hg within the potential range of 0.3 V–1.5 V. Ju et al. reported the MoS_2 nano flowers as the cathode material for hybrid ion Li^+/Mg^{2+} battery and reported the remarkable enhancement of the electrochemical performance due to Mg stripping/plating at the anode side and Li^+ intercalation at the cathode side with a small contribution from Mg^{2+} adsorption at MoS_2 cathode. The MoS_2 nano flower-based hybrid Li^+/Mg^{2+} hybrid ion battery demonstrated high capacity, excellent rate capability, and long cycle life of 243 mA/hg at the 0.1 C rate and 108 mA/hg at the 5 C rate, respectively. Also, the capacity retention over 2300 cycles is reported to be 87.2 % [85]. Zhu et al. have used the introduction of defects in cathode material strategy for the enhancement of energy density

and stability of MIBs and accelerated the diffusion of Mg^{2+} in cathode materials. For demonstration, they have reported the synthesis of defective 2D MoS_2 nanosheets via the hydrothermal method and used as a cathode for MIBs. The discharge specific capacity of MIBs is found to be 152 mA/hg [86]. Liu et al. synthesized the ε-MnO_2 via facile potentiostatic electrodeposition and utilized for cathode material for MIBs. The interconnected nanoflakes of ε-MnO_2 and direct contact with the electrolyte are responsible for high electrochemical performance. The specific capacity and energy density of binder-free ε-MnO_2 were reported to be 259.3 mA/hg at 0.5 Ag^{-1} and 98.6 Wh/kg, respectively. The as-prepared cathode shows high stability and 94.3% retention in capacitance over 400 cycles [80].

10.7 MAGNESIUM-SODIUM (MG–NA) HYBRID ION BATTERIES

With the advance in the use of renewable energy, various nanomaterials have been used to make the batteries very efficient; LIBs satisfy all the requisite criterion, but the major challenge is the limitation of energy density. It also suffers the problems of dendrites formation, thermal runaway and most important part is that it is costly. Lithium was replaced by MIB, a magnesium-ion battery which has lots of advantages as an electrode material such as an excellent volumetric capacity of 3833 mA/h/cm^3 and gravimetric capacities of 2205 mA/hg, which is double as compared to lithium, lower flammability and safe to use; it has lower negative redox potential and forms non-dendrite morphology [3,87,88]. Magnesium-ion batteries require cathode of high energy density, enhanced rate capability and good cyclability. The major challenge in the selection of cathode of MIB is the undesirable effects of the host materials that prevent the insertion of magnesium. Some of the cathodes used are Chevrel phase MO_6S_8 and spinel TiS_2, but the energy densities were very less and a lower voltage was achieved less than 1.5 V. As compared to MIB, sodium-ion batteries are also gaining lots of momentum in the field of energy materials. SIB batteries [89] use Na as a cathode because there is a strict prohibition of Na as an anode because it is highly reactive and has dendrite formation issues. However, its plenty abundance has made it an attractive electrode material as it will lower the cost of manufacturing. Figure 10.14 [89] shows the charging and discharging of Mg/Na hybrid battery in the charging process, the reduction process takes place at magnesium anode and oxidation takes place at cathode. The converse effect takes place during the discharging process.

There are many interesting features of sodium-magnesium hybrid ion batteries. Choosing magnesium as an electrode material has many advantages such as high capacity, availability, low cost and its safety. Sodium ion as a cathode material has lots of importance like generating high voltage, high energy density, found in abundance, low cost and good cyclability. The electrolyte should allow the transport of Mg ion and Na-ion both in charging and discharging of the battery. Its oxidation and reduction process should match with the operating voltage of the electrodes. This battery mainly works on the principle of sodium-ion insertion or extraction in the cathode and dissolution or deposition of magnesium ion at the anode during the cycles of charging and discharging. The stability of the oxidation state of the magnesium electrolyte [89] should not exceed the Na negative electrode. Moreover, the operating range of the cathode should be in the range the discharge voltage should not be very low. The electrolyte should be free from any materials which will affect

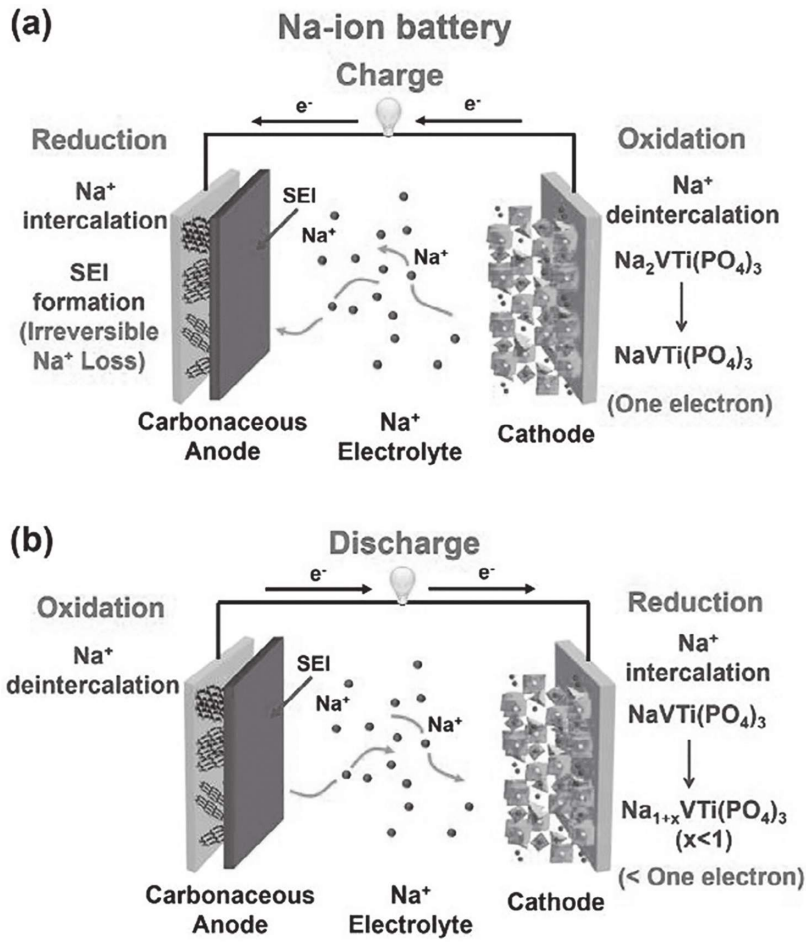


FIGURE 10.14 Charging and discharging phenomenon of Mg/Na hybrid battery [89]. (Reproduced with permission Elsevier, © 2020.)

the deposition or dissolution of Mg. Moreover, the recent research highlights that sodium magnesium hybrid ion battery is demonstrated in Table 10.13.

The future of sodium and magnesium hybrid ion batteries is truly bright. Because this hybrid battery utilizes the dendrite-free deposition of magnesium at anode and has the fast intercalation process of sodium ion at the cathode, which is very much required for the charge storage mechanism of the battery. This also increases the energy density of the battery. It can be commercialized by improving the materials of the electrolytes.

10.8 CONCLUSIONS AND FUTURE PROSPECTIVE

The recent advances in the energy storage system alternative to the lithium batteries/LIBs have been reviewed in detail. The cathode, anode and electrolyte materials

TABLE 10.13
Recent Research Advancements in Anode and Cathode Material for Sodium–Magnesium Hybrid Ion Battery

Types of Battery	Anode	Cathode	Electrolyte	Characteristics	References
$MgNaCrO_2$	Mg	$NaCrO_2$	PhMgCl-$AlCl_3$, MgAPC, $NaCB_{11}H_{12}$, dual salt electrolyte	Energy density −183 Wh Kg^{-1} at voltage 2.3 V average 50 cycles	[90]
Sodium–Magnesium hybrid battery	Mg metal	FeS_2 (nanocrystal)	Dual salt containing Mg^{+2} and Na^{+1}	Good cathodic capacity; excellent Coulombic efficiency; rate capability	[91]
Mg Berlin green hybrid cell	Mg	Na (open frame work Berlin Green cathode)		Average discharge voltage is 2.2 V Stable cyclability 50 cycles	[92]
Mg–Na hybrid	Mg	$Na_3V_2(PO_4)_3$		Voltage 2.6 V Energy density 150 Wh Kg^{-1} Good capacity	[93]
NVTP	Mg	$Na_2VTi(PO_4)_3$ NASICON structure	Dual ion electrolyte Mg^{+2} and Na^{+1}	High capacity of 168 mA hg^{-1} Cyclability of 1000 cycles	[89]
Mg/Na hybrid aqueous battery	$NaTi_2(PO_4)_3$	Mn_3O_4	Mg^{+2} and Na^{+1} hybrid electrolyte	Discharge potential at 1.2 V Energy density of 23.6 Wh Kg^{-1} Excellent cyclability	[94]

used in the different batteries have been discussed thoroughly. The operating principle of different batteries such as alkaline batteries, sodium-ion battery, magnesium-ion battery and sodium-magnesium hybrid ion battery with the key advancement in their architecture and energy efficiency is discussed in detail. The electrochemical technologies related to electrode materials and electrolytes have been discussed with the recent advancements including adopted methods of synthesis, use of nanostructured material for cathode and anode and applicability of solid electrolyte. While reviewing the status of different battery systems, it has been observed that there is a lot of scope for the development of nickel-based batteries, sodium-ion batteries and magnesium-based batteries. These batteries can replace the monopoly of lithium batteries in the future.

REFERENCES

[1] Rechargeable Batteries, Chemistry LibreTexts. (2013). https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Electrochemistry/Exemplars/Rechargeable_Batteries. (Accessed: August 24, 2021).

[2] G.J. May, A. Davidson, B. Monahov, Lead batteries for utility energy storage: A review, *J. Energy Stor.* 15 (2018) 145–157.

[3] Y. Liang et al., A review of rechargeable batteries for portable electronic devices, *InfoMat*. 1 (2019) 6–32.

[4] P.A. Marsal, K. Karl, L.F. Urry, Dry cell, US2960558A, (1960). https://patents.google.com/patent/US2960558A/en. (Accessed: August 11, 2021).

[5] A.R. Mainar, L.C. Colmenares, J.A. Blázquez, I. Urdampilleta, A brief overview of secondary zinc anode development: The key of improving zinc-based energy storage systems, *Int. J. Energy Res*. 42 (2018) 903–918. https://doi.org/10.1002/er.3822.

[6] D. Linden, T.B. Reddy, eds., *Handbook of Batteries*, 3rd ed., McGraw-Hill: New York, 2002.

[7] W. Li et al., Nickel cobalt sulfide nanostructure for alkaline battery electrodes, *Adv. Func. Mater.* 28 (2018) 1705937. https://doi.org/10.1002/adfm.201705937.

[8] N. Zhang et al., Rechargeable aqueous zinc–manganese dioxide batteries with high energy and power densities, *Nat. Commun*. 8 (2017) 405. https://doi.org/10.1038/s41467-017-00467-x.

[9] Nickel in batteries | Nickel Institute, (n.d.). https://nickelinstitute.org/about-nickel/nickel-in-batteries/. (Accessed: August 22, 2021).

[10] P.-J. Tsais, L.I. Chan, [11]Nickel-based batteries: Materials and chemistry, in: Z. Melhem (Ed.), *Electricity Transmission, Distribution and Storage Systems*, Woodhead Publishing, Swaston, 2013, pp. 309–397. https://doi.org/10.1533/9780857097378.3.309.

[11] J.P. Barton, R.J.L. Gammon, A. Rahil, Characterisation of a nickel–iron battolyser, an integrated battery and electrolyser, *Fron. Energy Res.* 8 (2020) 318. https://doi.org/10.3389/fenrg.2020.509052.

[12] Y. Zeng, X. Zhang, X. Mao, P.K. Shen, D.R. MacFarlane, High-capacity and high-rate Ni–Fe batteries based on mesostructured quaternary Carbon/Fe/FeO/Fe_3O_4 hybrid material, *Science*. 24 (2021) 102547. https://doi.org/10.1016/j.isci.2021.102547.

[13] H. Wang et al., An ultrafast Nickel–Iron battery from strongly coupled inorganic nanoparticle/nanocarbon hybrid materials, *Nat. Commun*. 3 (2012) 917. https://doi.org/10.1038/ncomms1921.

[14] Z. Lu, X. Wu, X. Lei, Y. Li, X. Sun, Hierarchical nanoarray materials for advanced nickel–zinc batteries, *Inorg. Chem. Front.* 2 (2015) 184–187. https://doi.org/10.1039/C4QI00143E.

[15] J. Phillips, S. Mohanta, M. Geng, J. Barton, B. McKinney, J. Wu, Environmentally friendly nickel–zinc battery for high rate application with higher specific energy, *ECS Trans*. 16 (2009) 11. https://doi.org/10.1149/1.3087437.

[16] M.A. Nazri et al., Screen-printed nickel–zinc batteries: A review of additive manufacturing and evaluation methods, *3D Print. Add. Manu*. 8 (2021) 176–192. https://doi.org/10.1089/3dp.2020.0095.

[17] Y. Liu, Z. Yang, J. Yan, Zinc hydroxystannate as high cycle performance negative electrode material for zn/ni secondary battery, *J. Electrochem. Soc*. 163 (2016) A3146. https://doi.org/10.1149/2.1411614jes.

[18] Avoiding short circuits from zinc metal dendrites in anode by backside-plating configuration - PubMed, (n.d.). https://pubmed.ncbi.nlm.nih.gov/27263471/. (Accessed: August 29, 2021).

[19] U. Koehler, Chapter 2–general overview of non-lithium battery systems and their safety issues, in: J. Garche, K. Brandt (Eds.), *Electrochemical Power Sources: Fundamentals, Systems, and Applications*, Elsevier, 2019: pp. 21–46. https://doi.org/10.1016/B978-0-444-63777-2.00002-5. Netherland.

[20] N. Omar et al., Analysis of nickel-based battery technologies for hybrid and electric vehicles, in: reference module in chemistry, In *Reference Module in Chemistry, Molecular Sciences and Chemical Engineering*, Elsevier, 2014. https://doi.org/10.1016/B978-0-12-409547-2.10740-1.

[21] P. Krivik, P. Baca, Electrochemical energy storage, in: Energy Storage - Technologies and Applications. London: IntechOpen, 2013. Available: https://www.intechopen.com/chapters/42271; doi: 10.5772/52222 (Accessed on 16 Aug 2022)..

[22] K. Scott, Recycling | Nickel–Metal hydride batteries, in: J. Garche (Ed.), *Encyclopedia of Electrochemical Power Sources*, Elsevier, Amsterdam, 2009: pp. 199–208. https://doi.org/10.1016/B978-044452745-5.00401-9.

[23] A. Taniguchi, N. Fujioka, M. Ikoma, A. Ohta, Development of nickel/metal-hydride batteries for EVs and HEVs, *J. Power Sources*. 100 (2001) 117–124. https://doi.org/10.1016/S0378-7753(01)00889-8.

[24] E. Lemaire-Potteau, M. Perrin, S. Genies, Batteries | charging methods, in: J. Garche (Ed.), *Encyclopedia of Electrochemical Power Sources*, Elsevier, Amsterdam, 2009: pp. 413–423. https://doi.org/10.1016/B978-044452745-5.00885-6.

[25] F. Feng, M. Geng, D.O. Northwood, Electrochemical behaviour of intermetallic-based metal hydrides used in Ni/metal hydride (MH) batteries: a review, *Int. J. Hydro. Energy*. 26 (2001) 725–734. https://doi.org/10.1016/S0360-3199(00)00127-0.

[26] B.I. Tsenter, V.M. Sergeev, A.I. Kloss, Hermetically sealed nickel-hydrogen storage cell, US3669744A, 1972. https://patents.google.com/patent/US3669744/en (Accessed: August 15, 2021).

[27] J.-Y. Hwang, S.-T. Myung, Y.-K. Sun, Sodium-ion batteries: present and future, *Chem. Soc. Rev.* 46 (2017) 3529–3614. https://doi.org/10.1039/C6CS00776G.

[28] M. Fan, H. Yu, Y. Chen, High-capacity sodium ion battery anodes based on CuO nanosheets and carboxymethyl cellulose binder, *Mater. Technol*. 32 (2017) 598–605. https://doi.org/10.1080/10667857.2017.1295628.

[29] N. Wang, Q. Liu, Y. Li, J. Chen, J. Gu, W. Zhang, D. Zhang, Self-crosslink assisted synthesis of 3D porous branch-like Fe3O4/C hybrids for high-performance lithium/sodium-ion batteries, *RSC Adv*. 7 (2017) 50307–50316. https://doi.org/10.1039/C7RA09348A.

[30] M. Hu, H. Zhou, X. Gan, L. Yang, Z.-H. Huang, D.-W. Wang, F. Kang, R. Lv, Ultrahigh rate sodium ion storage with nitrogen-doped expanded graphite oxide in ether-based electrolyte, *J. Mater. Chem. A*. 6 (2018) 1582–1589. https://doi.org/10.1039/C7TA09631C.

[31] Q. Shen, P. Jiang, H. He, C. Chen, Y. Liu, M. Zhang, Encapsulation of $MoSe_2$ in carbon fibers as anodes for potassium ion batteries and nonaqueous battery–supercapacitor hybrid devices, *Nanoscale*. 11 (2019) 13511–13520. https://doi.org/10.1039/C9NR03480C.

[32] Y. Li, L. Mu, Y.-S. Hu, H. Li, L. Chen, X. Huang, Pitch-derived amorphous carbon as high performance anode for sodium-ion batteries, *Energy Stor. Mater.* 2 (2016) 139–145. https://doi.org/10.1016/j.ensm.2015.10.003.

[33] Z. Zhang, X. Zhao, J. Li, Facile synthesis of nanostructured MnO_2 as anode materials for sodium-ion batteries, *Chem. Nano. Mat*. 2 (2016) 196–200. https://doi.org/10.1002/cnma.201500194.

[34] Y.-X. Wang, et al., Reversible sodium storage via conversion reaction of a MoS_2–C composite, *Chem. Commun*. 50 (2014) 10730–10733. https://doi.org/10.1039/C4CC00294F.

[35] X.-F. Luo, et al., Graphene nanosheets, carbon nanotubes, graphite, and activated carbon as anode materials for sodium-ion batteries, *J. Mater. Chem. A*. 3 (2015) 10320–10326. https://doi.org/10.1039/C5TA00727E.
[36] Y. Lu, P. Zhou, K. Lei, Q. Zhao, Z. Tao, J. Chen, Selenium Phosphide (Se_4P_4) as a new and promising anode material for sodium-ion batteries, *Adv. Energy Mater.* 7 (2017) 1601973. https://doi.org/10.1002/aenm.201601973.
[37] Y. Park, et al., Sodium terephthalate as an organic anode material for sodium ion batteries, *Adv. Mater.* 24 (2012) 3562–3567. https://doi.org/10.1002/adma.201201205.
[38] T. Risthaus, et al., $P_3Na_{0.9}Ni_{0.5}Mn_{0.5}O_2$ Cathode material for sodium ion batteries, *Chem. Mater.* 31 (2019) 5376–5383. https://doi.org/10.1021/acs.chemmater.8b03270.
[39] Z.-Y. Li, et al., Modulating the electrochemical performances of layered cathode materials for sodium ion batteries through tuning coulombic repulsion between negatively charged TMO_2 slabs, *ACS Appl. Mater. Interfaces.* 10 (2018) 1707–1718. https://doi.org/10.1021/acsami.7b15590.
[40] Z. Wang, et al., Ion-exchange synthesis of high-energy-density prussian blue analogues for sodium ion battery cathodes with fast kinetics and long durability, *J. Power Sources.* 436 (2019) 226868. https://doi.org/10.1016/j.jpowsour.2019.226868.
[41] Y.-N. Zhou, et al., Air-stable and high-voltage layered p3-type cathode for sodium-ion full battery, *ACS Appl. Mater. Interfaces*. 11 (2019) 24184–24191. https://doi.org/10.1021/acsami.9b07299.
[42] X. Pu, et al., $Na_4Fe_3(PO_4)_2P_2O_7$/C nanospheres as low-cost, high-performance cathode material for sodium-ion batteries, *Energy Storage Mater.* 22 (2019) 330–336. https://doi.org/10.1016/j.ensm.2019.02.017.
[43] Y. Wang, et al., Electrochemical performance of large-grained $NaCrO_2$ cathode materials for Na–Ion batteries synthesized by decomposition of $Na_2Cr_2O_7{\cdot}2H_2O$, *Chem. Mater.* 31 (2019) 5214–5223. https://doi.org/10.1021/acs.chemmater.9b01456.
[44] H. Li, et al., Rational architecture design enables superior Na storage in greener NASICON-$Na_4MnV(PO_4)_3$ Cathode, *Adv. Energy Mater.* 8 (2018) 1801418. https://doi.org/10.1002/aenm.201801418.
[45] M. Mao, T. Gao, S. Hou, C. Wang, A critical review of cathodes for rechargeable Mg batteries, *Chem. Soc. Rev.* 47 (2018) 8804–8841.
[46] D. Aurbach, Z. Lu, A. Schechter, Y. Gofer, H. Gizbar, R. Turgeman, Y. Cohen, M. Moshkovich, E. Levi, Prototype systems for rechargeable magnesium batteries, *Nature*. 407 (2000) 724–727.
[47] J. Giraudet, D. Claves, K. Guérin, M. Dubois, A. Houdayer, F. Masin, A. Hamwi, Magnesium batteries: Towards a first use of graphite fluorides, *J. Power Sources*. 173 (2007) 592–598.
[48] P. Novák, R. Imhof, O. Haas, Magnesium insertion electrodes for rechargeable nonaqueous batteries—a competitive alternative to lithium?, *Electro. Acta*. 45 (1999) 351–367.
[49] M.S. Whittingham, Lithium batteries and cathode materials, *Chem. Rev.* 104 (2004) 4271–4302.
[50] J.B. Goodenough, Y. Kim, Challenges for rechargeable Li batteries, *Chem. Mater.* 22 (2010) 587–603.
[51] J.D. Genders, D. Pletcher, Studies using microelectrodes of the Mg (II)/Mg couple in tetrahydrofuran and propylene carbonate, *J. Electro. Chem. Inter. Electro.* 199 (1986) 93–100.
[52] O.R. Brown, R. McIntyre, The magnesium and magnesium amalgam electrodes in aprotic organic solvents a kinetic study, *Electro. Acta*. 30 (1985) 627–633.
[53] Y. Zhu, et al., Hydrated $Mg_xV_5O_{12}$ cathode with improved Mg^{2+} storage performance, *Adv. Energy Mater.* 10 (2020) 2002128.

[54] M.M. Huie, D.C. Bock, E.S. Takeuchi, A.C. Marschilok, K.J. Takeuchi, Cathode materials for magnesium and magnesium-ion based batteries, *Coordi. Chem. Rev.* 287 (2015) 15–27.
[55] M. Rastgoo-Deylami, M.S. Chae, S.-T. Hong, $H_2V_3O_8$ as a high energy cathode material for nonaqueous magnesium-ion batteries, *Chem. Mater.* 30 (2018) 7464–7472.
[56] C. Pei, F. Xiong, J. Sheng, Y. Yin, S. Tan, D. Wang, C. Han, Q. An, L. Mai, VO_2 nanoflakes as the cathode material of hybrid magnesium–lithium-ion batteries with high energy density, *ACS Appl. Mater. Interfaces*. 9 (2017) 17060–17066.
[57] L. Blanc, et al., Toward the development of a high-voltage Mg cathode using a chromium sulfide host, *ACS Mater. Lett*. 3 (2021) 1213–1220.
[58] J. Bae, H. Park, X. Guo, X. Zhang, J. Warner, G. Yu, High-performance magnesium metal battery via switching passivation film into solid electrolyte interphase, *Energy Environ. Sci*. 14(8) (2021) 4391–4399.
[59] Y. Shao, et al., 3D crumpled ultrathin 1T MoS_2 for inkjet printing of Mg-ion asymmetric micro-supercapacitors, *ACS Nano.* 14 (2020) 7308–7318.
[60] L.F. Wan, D. Prendergast, Ion-pair dissociation on α-MoO_3 surfaces: Focus on the electrolyte–cathode compatibility issue in Mg batteries, *J. Phys. Chem. C*. 122 (2018) 398–405.
[61] P.G. Bruce, F. Krok, J. Nowinski, V.C. Gibson, K. Tavakkoli, Chemical intercalation of magnesium into solid hosts, *J. Mater. Chem*. 1 (1991) 705–706.
[62] D. Wu, J. Zeng, H. Hua, J. Wu, Y. Yang, J. Zhao, NaV_6O_{15}: A promising cathode material for insertion/extraction of Mg^{2+} with excellent cycling performance, *Nano Res*. 13 (2020) 335–343.
[63] A. Mukherjee, S. Taragin, H. Aviv, I. Perelshtein, M. Noked, Rationally designed vanadium pentoxide as high capacity insertion material for Mg-Ion, *Adv. Func. Mater.* 30 (2020) 2003518.
[64] A. Das, et al., Electrolytes for magnesium-ion batteries next generation energy storage solutions for powering electric vehicles, in: *Ceramic and Specialty Electrolytes for Energy Storage Devices*, CRC Press, 2021. pp. 177–191. Florida, US.
[65] Y. Li, Q. Dang, W. Chen, L. Tang, M. Hu, Recent advances in rechargeable batteries with prussian blue analogs nanoarchitectonics, *J. Inorganic and Organ. Polym. Mater.* (2021) 1–17.
[66] P. Marzak, M. Kosiahn, J. Yun, A.S. Bandarenka, Intercalation of Mg^{2+} into electrodeposited prussian blue analogue thin films from aqueous electrolytes, *Electro. Acta*. 307 (2019) 157–163.
[67] S. Rasul, S. Suzuki, S. Yamaguchi, M. Miyayama, Synthesis and electrochemical behavior of hollandite MnO_2/acetylene black composite cathode for secondary Mg-ion batteries, *Solid State Ionics*. 225 (2012) 542–546.
[68] N. Kumagai, S. Komaba, H. Sakai, N. Kumagai, Preparation of todorokite-type manganese-based oxide and its application as lithium and magnesium rechargeable battery cathode, *J. Power Sources*. 97 (2001) 515–517.
[69] N. Kuganathan, E.I. Gkanas, A. Chroneos, Mg_6MnO_8 as a magnesium-ion battery material: Defects, dopants and Mg-ion transport, *Energies*. 12 (2019) 3213.
[70] Y. Tuhudahong, Y. Nuli, Q. Chen, J. Yang, J. Wang, Vanadium doped $Mg_{1.03}Mn_{0.97}SiO_4$ cathode materials for rechargeable magnesium batteries, *Mat. Sci.* 2 (2012) 139–144.
[71] J. Heath, H. Chen, M.S. Islam, $MgFeSiO_4$ as a potential cathode material for magnesium batteries: iIon diffusion rates and voltage trends, *J. Mater. Chem. A*. 5 (2017) 13161–13167.
[72] Q.D. Truong, M.K. Devaraju, I. Honma, Nanocrystalline $MgMnSiO_4$ and $MgCoSiO_4$ particles for rechargeable Mg-ion batteries, *J. Power Sources*. 361 (2017) 195–202.
[73] L.F. Wan, B.R. Perdue, C.A. Apblett, D. Prendergast, Mg desolvation and intercalation mechanism at the MO_6S_8 chevrel phase surface, *Chem. Mater.* 27 (2015) 5932–5940.

DNYANPATH PUBLICATION

An Introduction to

Nano **Materials** and Nano **Technology**

Editors

Dr. A. B. Lad
Dr. G. T. Lamdhade
Dr. V. S. Kalyamwar

Authors

Dr. R. M. Agrawal
Dr. V. U. Rahangdale
Dr. D. P. Deshmukh
Dr. P. D. Shirbhate
Dr. S. D. Charpe

An Introduction to
Nano Materials and Nano Technology

Published by the **DnyanPath Publication** (INDIA)
The First Edition published in 22th December 2022

ISBN 13 : 978-93-94661-19-6

DnyanPath® Publication
Write well-Right now
ISO 9001 : 2015

A Leading **National Books Publishing** House In India

Visit us
www.dnyanpath.org

Reg. Office	:	FFS-A, Block C, First Floor, Venus Plaza, Shegaon Naka, V.M.V. Road, Amravati
Our Network	:	Maharashtra, Delhi, Gujrat, Chattisgarh, Telangana, Bihar
Visit us	:	www.dnyanpath.com
Contact us	:	info@dnyanpath.com, dnyanpathpub@gmail.com
Phone	:	08600353712, 09503237806

Printed at Shri Gurudeo Printers, Amravati
Mahatma Fule Sankul, Shegaon Naka,
V.M.V. Road, Amravati - 444603 (Maharashtra)

₹ : 210/-

An Introduction to
Nano Materials and Nano Technology

- EDITORS -

Dr. A. B. Lad
Professor and Head
Department of Physics
Amolakchand Mahavidyalaya,
Yavatmal

Dr. G. T. Lamdhade
Professor
Department of Physics
Vidya Bharti Mahavidyalaya
Camp, Amravati

Dr. V. S. Kalyamwar
Associate Professor
Department of Physics
Bhartiya Mahavidyalaya, Amravati

- AUTHORS -

Dr. R. M. Agrawal
M.Sc., Ph.D.
Assistant Professor,
Department of Physics
Shri. R.L.T. College of Science,
Civil Lines, Akola.

Dr. D. P. Deshmukh
M.Sc., M.Phil., Ph.D.
Assistant Professor,
Department of Physics
Late R. Bharti Arts, Commerce and
Smt. S.R. Bharti Science College, Arni

Dr. V. U. Rahangdale
M.Sc., Ph.D.
Assistant Professor,
Department of Physics
Jagat Arts, Commerce and I.H.P. Science
College, Goregaon, Dist. Gondiya

Dr. P. D. Shirbhate
M.Sc., Ph.D.
Assistant Professor,
Department of Physics
Gopikabai Sitiram Gawande
College, Umarkhed

Dr. S. D. Charpe
M.Sc., Ph.D., B.Ed.
Assistant Professor,
Department of Physics
J.D. Patil Sangludkar Mahavidyalaya,
Daryapur

Published by the **DnyanPath Publication** (INDIA)
The First Edition published in 22th December 2022
ISBN 13 : 978-93-94661-19-6

CHAPTER - 5

Hands on Nanomaterials

5.1 Synthesis of Metal Oxide (MOx) Nanomaterials by Different Methods

In this chapter we shall concisely discuss some easy ways to perform experiments which will enable the beginners to get some experience in the synthesis of nanomaterials. We shall mention the required equipment and outline of the procedure. These experiments can possible to perform in any moderately equipped laboratory with low cost investment.

It may be noted that following procedures are only illustrative and only to give one a flavour of nanotechnology experiments and are not necessarily the best possible procedures for obtaining particular nanoparticles.

One can follow the literature and obtain better result or product as nanomaterial following some more constraint conditions or procedures.

So, author can tries to elaborate some synthesis methods of Metal Oxide (MOx) nanomaterials by different ways.

- NIPER is developing regulatory approval guidelines for nanotechnology based drugs and standards for toxicological tests in nano based drug delivery systems.
- Firms involved in nanotechnology based product development primarily products addressing water, textile, drug delivery have undertaken Life Cycle Analysis (LCA) partnering with research institutes / universities.
- In 2010, DST appointed a task force which has been asked to advice Nano Mission Council to develop a regulatory body for nanotechnology in India.
- Standardization remains an area of concern. India, has only taken initial first steps in addressing standardization issue.
- Address issues keeping the global market regulation in consideration.

The various institutes in India can have important role in taking initiative in this direction. Coordination is urgently needed to serve as a baseline even for collaborative work of multiple institutes. Only by creating such a well-functioning governance structure can India make nanotechnology into a success.

■ ■ ■

References

1. Emergence of nanotechnology in India, Deva Prasad (National Law School of India, Bangalore), Digital Dividend Symposium on potential benefits of new technologies, Nov 2015
2. Draft-Guidelines @ dst.gov.in sites https://dst.gov.in/sites/default/files/Draft-Guidelines%20.pdf

- About Authors -

Dr. Rohitkumar M. Agrawal
M.Sc., Ph.D.
Assistant Professor, Department of Physics
Shri. R.L.T. College of Science, Civil Lines, Akola.

Dr. Vijay U. Rahangdale
M.Sc., Ph.D.
Assistant Professor, Department of Physics
Jagat Arts, Commerce and I.H.P. Science College, Goregaon, Dist. Gondiya

Dr. Dhananjay P. Deshmukh
M.Sc., M.Phil., Ph.D.
Assistant Professor, Department of Physics
Late R. Bharti Arts, Commerce and Smt. S.R. Bharti Science College, Arni

Dr. Praful D. Shirbhate
M.Sc., Ph.D.
Assistant Professor, Department of Physics
Gopikabai Sitiram Gawande College, Umarkhed

Dr. Sushil D. Charpe
M.Sc., Ph.D. , B.Ed.
Assistant Professor, Department of Physics
J.D. Patil Sangludkar Mahavidyalaya, Daryapur

DnyanPath® Publication
Write well - Right now
ISO 9001 : 2015
A Leading **National Books Publishing** House In India

₹: 210/-
ISBN 978-93-94661-19-6

dnyanpathpub@gmail.com www.dnyanpath.org 08600353712, 09503237806

Synthesis of Physico-Chemical Properties of Metal Oximes, Hydrazones and Semicarbazones

Dr. P. M. Dahikar

LULU PUBLICATION
2022

Price: 350/-

Synthesis of Physico-Chemical Properties of Metal Oximes, Hydrazones and Semicarbazones

Dr. P. M. Dahikar

ISBN– 978-1-4583-1036-1

Published by,
Lulu Publication
3101 Hillsborough St,
Raleigh, NC 27607,
United States.

Printed by,
Laxmi Book Publication,
258/34, Raviwar Peth,
Solapur, Maharashtra, India.
Contact No. : 9595359435
Website: http://www.lbp.world
Email ID: apiguide2014@gmail.com

CONTENTS

Synthesis of Physico-Chemical Properties of Metal Oximes, Hydrazones And Semicarbazones

Dr. P. M. Dahikar

RAMAN-2022
2nd International Conference on Recent Advances in Material Science and Nanotechnology
In Association with International Journal of Scientific Research in Science and Technology
Volume 9 | Issue 13 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

Synthesis of Substituted-4, 6-Diaryl-2-Imino-6h-2, 3-Dihydro-1, 3-Thiazine

A. S. Dighade
Department of Chemistry, J.D. Patil Sangludkar Mahavidyalay, Daryapur, Maharashtra, India

ABSTRACT
Six different VII (a) –VII (f) thiazine were synthesized from flavanone VI (a) –VI (f) in ethanol containing little KOH and piperidine by the interaction of thiourea. The structures of some compounds were confirmed on the basis of IR, NMR, and Mass analysis.

Keywords: Iodo Acetophenone, Iodo- Diketone, Substituted iodo- Flavanone, Substituted iodo- 1, 3-Thiazine.

I. INTRODUCTION

The heterocyclic compounds which contain nitrogen, sulphur and oxygen possess an enormous significance in the field of medicinal chemistry. Heterocyclic compounds are abundant in nature and have acquired more importance because they form the structural subunits of many natural products such as vitamins, hormones, antibiotics and drug molecules. 1,3- thiazines which contains nitrogen and sulphur as a part of six membered heterocyclic ring (N-C-S). This ring also present in some of the medicinally important compounds like Xylazine(agonist at the α_2- adrenergic receptor is used for sedation, anesthesia, muscle relaxation, and analgesia in animals[1])

Chhaya D. Badnakhe and P. R. Rajput[2] have synthesized and study of substituted 1,3-thiazine and their nanoparticles on phytotic growth of some vegetable crops. Koketsu et al.[3], have synthesized 4- hydroxy-4-metyl-2, 6-diphenyl-5 5, 6-dihydro-4-H-1, 3-thiazine. Leflemme et al.[4] have synthesized dihydro and tetrahydro-1, 3-thiazinederivatives from β aryl-β-amino acid.

Thiazine derivatives were reported to possess diverse biological activities including anticonvulsant[5] antimicrobial[6,7,8,9,10,11], analgesic[12], anti-inflammatory and ulcerogenic[13,14],anticancer[15,16,17,18,19], antidiabetic[20], immunotropic[21], antianxiety[22], insecticidal and pesticidal[23], antitubercular[24], anthelmintic[25], anesthetic[26],and antiviral[27].

II. EXPERIMENTAL

Melting points of all synthesized compounds were determined in open capillary tube and are uncorrected. The purity of compounds were checked by TLC using silica G. I. R. spectra were recorded on Perkin-Climer-841 spectrometer (cm^{-1}) in KBr disc and NMR (Brucker Avance II 400 NMR) using $CDCl_3$ as solvent.

Synthesis of 2-hydroxy-3-iodo-5-methyl-acetophenone (Compound-1)

By known method from p-cresol to p-crysyl-acetate prepared and then by fries migration-2-hydroxy-5-methyl acetophenone which on iodination gives 2-hydroxy-3-iodo-5-methyl acetophenone (Comp.-1).

Synthesis of 2-benzoyl-3-iodo-5-methyl acetophenone (IV)

2-benzoyl-oxy-3-iodo-5-methyl acetophenone was prepared from compound no. (I) by using benzoic acid, $POCl_3$ in pyridine and structure was confirmed on the basis of IR and NMR spectral analysis.

Synthesis of Diketone (1-(2-hydroxy-3-iodo-5-methyl phenyl)-3-phenyl-1, 3-propanedione) (V)

1-(2-hydroxy-3-iodo-5-methyl phenyl)-3-phenyl-1, 3-propanedione was prepared from by Baker – Venkatraman Tranformation reaction. The structure was confirmed on the basis of IR, NMR and Mass spectral analysis.

Synthesis different substituted flavanone and chromanone VI (a) – VI (f)

Compound no. V propanedione was reacted with six different aromatic aldehydes in ethanol containing few drops of piperidine gaves six different substituted flavanones and chromanones i.e. VI(a) – VI(f). The structures of some flavanone were confirmed on the basis of IR, NMR and Mass spectral analysis. The compounds prepared were listed in table 1.

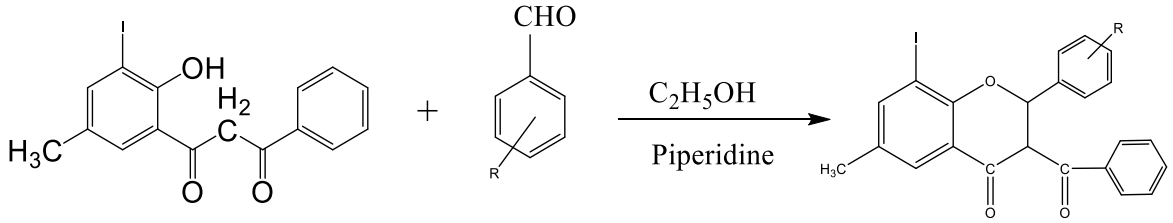


Table 1 3-aroyl flavanones and 3-aroyl chromanones VIa – VI f

Exp. No	Comp. No.	Name of compounds	M.P in ^{0}c	yield
82	VIa	3-benzoyl-2'-phenyl -6-methyl- 8 -iodo flavanone.	117 ^{0}c	76%
83	VIb	3-benzoyl-4'-methoxy -6-methyl- 8-iodo flavanone.	76 ^{0}c	68%
84	VIc	3-benzoyl-4'-ethenyl-6-methyl-8-iodo chromanone.	98 ^{0}c	63%
85	VId	3-benzoyl-2'-furyl-6-methyl-8-iodo chromanone.	86 ^{0}c	65%
86	VIe	3-benzoyl-2'-hydroxy-6-methyl-8-iodo flavanone.	110 ^{0}c	66%
87	VIf	3-benzoyl-4'- chloro-6-methyl-8-iodo flavanone.	122 ^{0}c	70%

Characterization data of compounds

2-Hydroxy-3-iodo-5-metyl acetophenone

IR (KBr) ν_{max} cm^{-1}: 3200 cm^{-1} (s) – phenolic OH , 2919 cm^{-1} (s) – Ar- C-H stretching, 1635 cm^{-1} C = O stretching, 1082-1007 cm^{-1} (S) CH_3 - stretching , 1020 cm^{-1} (S) CH_3 stretching, 550 cm^{-1} C-I stretching.

^{1}H NMR: [δ $CDCl_3$]: 2.3 δ (S, 3H, Ar- CH_3), 2.6 δ (S, 3H, $COCH_3$), 7.5 δ (S, 1H, Ar-H), 7.7 δ (S, 1H, Ar-H), 12.9 δ (S, 1H, Ar-OH).

TOF MS ES+: 345 Molecular ion at 275.1 m/z assign the molecular formula $C_9H_9IO_2$ and 1362 Base peak at 119.1 m/z assign the molecular formula C_8H_7O.

2-benzoyl-3-iodo-5-methyl acetophenone

IR (KBr) ν_{max} cm^{-1}: 3046 cm^{-1} (s) –C-H stretching in Ar-H, 1686 cm^{-1} C = O stretching, 2919 cm^{-1} (S) C-H stretching in CH_3 , **1562.09** cm^{-1} (S) **C=C ring** stretching, 1212.5 cm^{-1} (S) Ar-O stretching, 549 cm^{-1} C-I stretching.

^{1}H NMR: [δ $CDCl_3$]: 2.25 δ (S, 3H, Ar- CH_3), 2.6 δ (S, 3H, Ar-CO-CH_3), 7.5 δ (S, 1H,Ar-H), 7.2-8.25 δ (m, 7H, Ar-H), 13 δ (S, 1H, Ar-OH).

(1-(2-hydroxy-3-iodo-5-methyl phenyl)-3-phenyl-1, 3-propanedione) Diketone

IR (KBr) ν_{max} cm^{-1}: 3045 cm^{-1} (s) Ar-H stretching , 1635 cm^{-1} C = O stretching, 3020 cm^{-1} (br) Ar-OH stretching , **1598-1447** cm^{-1} (S) **C=C ring** stretching vibration in aryl gp, 2919 cm^{-1} (S) Ar-CH_3 stretching, 536 cm^{-1} C-I stretching.

^{1}H NMR: [δ $CDCl_3$]: 2.1-2.3 δ (S, 3H, Ar- CH_3), **8.3-8.45** δ (d, 2H, for CH_2), 7.1-7.85 δ (m, 7H, Ar-H), 12.8 δ (S, 1H, Ar-OH).

TOF MS ES+: 760 Molecular ion at 380.0 m/z assign the molecular formula $C_{16}H_{13}IO_3$ and 7173 Base peak at 335.9 m/z assign the molecular formula $C_{15}H_{11}IO$.

3-benzoyl-4'-methoxy-6-methyl- 8-iodo flavanone

IR (KBr) ν_{max} cm^{-1}: 3056 cm^{-1} (s) Ar-CH stretching , 1692.35 cm^{-1} C = O stretching of aroyl gp, **1253.64** cm^{-1} (S) Ar-O stretching ,**1461.72-1439** cm^{-1} (S) **C=C ring** stretching vibration in aryl gp, 2914.56 cm^{-1} (S) Ar-CH_3 stretching, 1349.47 cm-1 (S) Pyrone, 573 cm^{-1} C-I stretching.

^{1}H NMR: [δ $CDCl_3$]: 2.2-2.40 δ (S, 3H, Ar- CH_3), **3.8** δ (S, 3H, Ar-O-CH_3), 6.8-7.9 δ (m, 11H, Ar-H), 3.0 δ (S, 1H, CH_A), 5.5 δ (S, 1H, CH_B).

TOF MS ES+: 579 Molecular ion at 498.2 m/z assign the molecular formula $C_{24}H_{19}IO_4$ and 16634 Base peak at 229.1 m/z assign the molecular formula $C_{16}H_{13}IO_2$.

3-benzoyl-2'-hydroxy-6-methyl-8-iodo flavanone

IR (KBr) ν_{max} cm^{-1}: 3336 cm^{-1}(br) Ar-OH stretching , 3133-3005 cm^{-1} (s) Ar-CH stretching , **1596-1667** cm^{-1} (s) C = O stretching of aroyl gp, **1197-1257** cm^{-1} (s) Ar-O stretching, **1535-1444** cm^{-1} (s) **C=C ring** stretching vibration in aryl gp, 2948 cm^{-1} (s) Ar-CH_3 stretching, 1347 cm-1 (s) Pyrone, 514 cm^{-1} (s) C-I stretching.

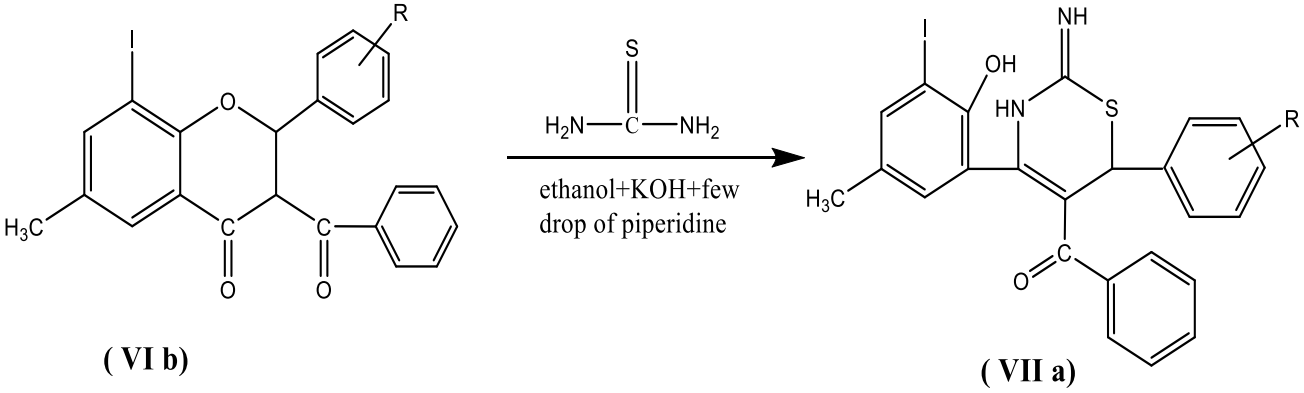
^{1}H NMR: [δ $CDCl_3$]: 2.1-2.6 δ (S, 3H, Ar- CH_3), **12.7-13.0** δ (br, 1H, Ar-OH), 7.2-7.85 δ (m, 13H, (1H) CH_A, (1H) CH_B **& (11H)** Ar-H),

TOF MS ES+: 520 Molecular ion at 484.0 m/z assign the molecular formula $C_{23}H_{17}IO_4$ and 6417 Base peak at 229.1 m/z assign the molecular formula $C_{15}H_{15}IO_2$.

Synthesis of substituted 4, 6-diaryl-2-imino-6H-2, 3-dihydro-1, 3-thiazine

Compound (VII_a -VII_f) 0.01 M, thiourea 0.01 M and 0.02 M KOH solution with a few drops of piperidine were refluxed in 25 mL ethanol for 2 to 2.5 hours. Dilute it with water and acidified with conc. HCl. The products were crystallized from ethanol. Physical data are shown in Table

Reaction



(VI b) **(VII a)**

Table 2 4, 6-diaryl-5-aroyl-2-imino-6H-2, 3-dihydro-1, 3-thiazines VIIa – VII f

Exp. No	Comp. No.	Name of compounds	M.P in ^{0}c	Yield
88	VIIa	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (phenyl) -2- imino- 6H- 2, 3- dihydro-1, 3-thiazine.	208 ^{0}c	70%
89	VIIb	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (4-methoxyphenyl) -2- imino- 6H- 2,3- dihydro-1,3-thiazine.	118 ^{0}c	68%
90	VIIc	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (-2-phenylethenyl) -2- imino- 6H- 2,3- dihydro-1,3-thiazine.	150^0 c	60%
91	VIId	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (2-furyl) -2- imino- 6H- 2,3- dihydro-1,3-thiazine.	89 ^{0}c	62%
92	VIIe	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (-2-hydroxyphenyl) -2- imino- 6H- 2,3- dihydro-1,3-thiazine.	98 ^{0}c	64%
93	VIIf	4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (-4-chlorophenyl) -2- imino- 6H- 2,3- dihydro-1,3-thiazine.	108 ^{0}c	65%

Characterization data of compound

Synthesis of 4- (2'- hydroxy -3-iodo-5-methylphenyl) -5-benzoyl -6- (4-methoxyphenyl) -2-imino- 6H- 2, 3-dihydro-1, 3-thiazine

IR (KBr) ν_{max} cm^{-1}: 3368.81 cm-1 (s) O-H streaching in phenol, 3056.26 cm^{-1} (s) Ar-H stretching, 2836.03 cm^{-1} (s) C=N-H streaching, 2945.49 cm^{-1} (s) C-N-H streaching, 1691 cm^{-1} (s) **C=N** streaching, 1256 cm^{-1} (s) C-**N streaching, 1637.47** cm^{-1} (s) C = O stretching of aroyl gp, **1555.67-1604.39**cm^{-1} (s) **C=C ring** stretching vibration in aryl gp,536 cm^{-1} (s) C-I stretching.

^{1}H NMR: [δ CDCl$_3$]: 2.3 δ (S, 3H, Ar- CH_3), 3.95-4.2 δ (S, 3H, O- CH_3),

3.6-3.9 δ (S, 2H, N-H & =N-H), 2.7 δ (S, 1H CH_A), **6.5-8.2** δ (m, **11H,** Ar-H).

TOF MS ES+: 425 Molecular ion at 554.2 m/z assign the molecular formula $C_{25}H_{21}IN_2O_3S$ and 12751 Base peak at 229.1 m/z assign the molecular formula C_7H_6IO.

III. RESULTS AND DISCUSSION

Compound **VIa – VIf** and **VIIa – VIIf** were synthesized through the route as shown in general reactions with R and R' as shown in Table 1 and 2. Physical data are given in Table 1 and 2. The synthesized compounds **Ie** and **IIe** were confirmed on the basis of IR, NMR spectral analysis.

IV. ACKNOWLEDGEMENT

Authors are thankful to Principal, J. D. Patil Sangludkar Mahavidyalaya Daryapur, H. O.D. Chemistry, J. D. Patil Sangludkar Mahavidyalaya Daryapur and thankful to RC SAIF Punjab University, Chandigarh for spectral analysis IR., NMR.

V. REFERENCES

[1]. Greene SA, Thurmon JC, Xylazine--a review of its pharmacology and use in veterinary medicine.J Vet Pharm and Ther 1988; 11(4):295-313.

[2]. Chhaya D. Badnakhe and P. R. Rajput, European J. of biomedical and pharmaceutical Sciences5(9), 313-318(2018).

[3]. M. Koketsu, M. Ebihara and H. Ishihara, J. Acta Crystallographica Section E, 62, Part 4, (2006) pp. 1218-1220.

[4]. Nicolas Leftemme, Patrick Dallemagne and Sylvain Rault, J. Tetrahydron Letters, 45(7), 1503-1505 (2004).

[5]. Ravindar B, Srinivasa Murthy M, Afzal Basha Shaik. Design, facile synthesis and biological evaluation of novel 1,3-thiazine derivatives as potential anticonvulsant agents. Asian J Pharma Clin Res 2016; 9(2):272-276.

[6]. Ravindar Bairam and Srinivasa Murthy M. Synthesis characterization and biological screening of some novel substituted 1,3-thaizine derivatives. Der Pharma Chemica 2015; 7(10):150-154.

[7]. Shaik K Yazdan, Gali V Sagar Afzal B Shaik. Biological and synthetic potentiality of chalcones. J Chem Phar Res 2015; 7(11):829-842.

[8]. Rathore MM. Synthesis and antimicrobial activities of some bromo-substituted-1, 3-thiazines. Int J Res Pham Biomed Sci 2013;4(1):59-62.

[9]. Silverstein R. Spectroscopic identification of organic compounds, 6th Edn, (John Wiley & Sons Inc., New York 1991; 60-70,119-176:191-200.

[10]. Ibadur R Siddiqui, Pravin K Singh. Novel one pot synthesis of 1,3-dithiins and 1,3-thiazines under microwave irradiation. Int J Chem 2007; 46B: 499-504.

[11]. Tarik El-Sayed Ali, Azza Mohammed El- Synthesis and antimicrobial activity of some new 1,3-thiazoles, 1,3,4- thiadiazoles, 1,2,4-triazoles and 1,3-thiazines incorporating acridine and 1,2,3,4-tetrahydroacridine moieties. Eur J Chem 2010; 1(1): 23.

[12]. Srikanth Jupudi, Sandeep Talari, Divya Karunakaram, Govindarajan R. Screening of in vitro anti-inflammatory activity of some newly synthesized 1,3-thiazine derivatives. Int J Rese Pharm Chem 2013; 3(2):213-220.

[13]. Vijay V Dabholkar, Sagar D Parab. 1, 3-Thiazines and 1, 3-pyrimidines derivatives and their biological evaluation for anti-inflammatory, analgesic and ulcerogenic activity. Hetero Letters 2011; 1(2):176-88.

[14]. Udupi RH, Bhat AR, Jacob J. Synthesis and biological evaluation of some biphenyl ether and thiazine derivatives. Ind J Hetro Chem 2005; 15:89.

[15]. Temple C, Wheeler GP, Comber RN, Elliot RD, Montgomery JA, Synthesis of potential anticancer agents, Pyrido[4,3-b][1,4]oxazines and pyrido[4,3-b][1,4] thiazines. J Med Chem 1983; 26:1641.

[16]. Sayaji S Didwagh, Pravina B Piste Aravind S Burungale, Avinash M Nalawade. Synthesis and antimicrobial evaluation of novel 3-(4,6- diphenyl-6H-1,3-thiazin-2-yl)-2-(4-methoxyphenyl) thiazolidin-4-one derivatives. J Appl Pharm Sci 2013; 3(11):122-127.

[17]. Roman Lesyk, Olena Vladzimirska, Serhiy Holota, Lucjusz Zprutko, Andrzej Gzella. New 5-substituted thiazolo[3,2-b][1,2,4]triazol-6-ones: Synthesis and anticancer evaluations. Eur J Med Chem 2007; 42: 641-648.

[18]. Wei Wang, Bing Zhao, Chao Xu, Wenpeng Wu. Synthesis and antitumor activity of the thiazoline and thiazine multithioether. Int J Org Chem 2012; 2: 117-120.

[19]. Beauchamp, Benardeau, Hilpert, Wang. 2-Aminodihydro [1,3] thiazines as bace 2-inhibitors, for the treatment of diabetes, patent scope. Wor Inte Pro Org 2011; 165.

[20]. Syntheses and pharmacological analysis of new derivatives of tetra hydro-[1,3]-thiazine and 2-thiobarbituric acid. Nat Cen Biot Inf 1981; 29(2):235-248.

[21]. Hong Min Wu, Kuo Zhou, Tao Wu, Yin Guang Cao. Synthesis of pyrazine-1,3-thiazine hybrid analogues as antiviral agent against HIV-1, influenza A (H1N1), enter virus 71(EV71), and coxsackievirus B3(CVB3). Chem Biol Drug Des 2016; 88:411-21.

[22]. Syntheses and pharmacological analysis of new derivatives of tetrahydro-[1,3]-thiazine and 2-thiobarbituric acid. Nat Cen Biot Inf 1981; 29(2): 235-48.

[23]. Srikanth Jupudi. Screening of in vitro anti-inflammatory activity of some newly synthesized 1,3-thiazine derivatives. Int J Res Phar and Chem 2013; 3: 213-20.

[24]. Foks H. Synthesis, structure and biological activity of 1, 2, 4-triazolo-1,3-thiazine derivatives. Pharm 1992; 47(10): 770-73.

[25]. Bhusari PK, Khedekar PB, Umathe SN, Bahekar RH, Rama R. Ind J Hete Chem 2000; 69:

[26]. Al-Khamees HA, Bayomi, SM, Kandil, HA, El-Thahir K. Microwave assisted green chemical synthesis of novel spiro[indole-pyrido thiazines], a system reluctant to be formed under thermal conditions. Eur J Med Chem 1990; 25: 103.

[27]. Turaska Rao, Bhongade S L, More SM, Dongarwar A S, Shende V S and Pande V B. Effects of lippia nodiflora extracts on motor coordination, exploratory behavior pattern, locomotor activity, anxiety and convulsions on albino mice. Asian J Pharm Clin Res 2011; 4(3):133-¬138.

About the Author

Dr. Anil Rameshwar Somwanshi

Dr. Anil Rameshwar Somwanshi has served as Associate Professor in Chemistry in different Collage Since 2006, Currently he is serving as associate professor at J. D. Patil Sangludkar Mahavidyalaya, Daryapur, District Amravati Since from 2019. He was awarded the Ph.D. degree in "Effect of Variou Parameters and Structure of Complexing Agent for Retrieval of Metal Ions form Solution Through Low Cost Adsorbent" by Sang Gadge Baba Amravati University, Amravati in 2021. He has published more than 20 research paper in several reputed edited journals at National and International level. He has also presented different papers in Seminar/Conference/Workshop.

Dr. Anil Rameshwar Somwanshi is also a Life Member of India Science Congress Association and Life Member of Nagpur University Teachers Association (NUTA) and life member of Amravati University Chemistry Teachers Association (AUCTA) .

Published by

Lulu.com
3101, Hillsborough St,
Raleigh, NC 27607,
United States.

9 781387 591954

Adsorption Technique for Removed of Heavy Metal Ions

Dr. Anil Rameshwar Somwanshi

Adsorption Technique for Removed of Heavy Metal Ions

Dr. Anil Rameshwar So

Adsorption Technique for Removed of Heavy Metal Ions

Dr. Anil Rameshwar Somwanshi

LULU PUBLICATION
2022

Price: 450/-

Adsorption Technique for Removed of Heavy Metal Ions

Dr. Anil Rameshwar Somwanshi

ISBN– 978-1-387-59195-4

Published by,
Lulu Publication
3101 Hillsborough St,
Raleigh, NC 27607,
United States.

Printed by,
Laxmi Book Publication,
258/34, Raviwar Peth, Solapur,
Maharashtra, India.
Contact No. : 9595359435
Website: http://www.lbp.world
Email ID: apiguide2014@gmail.com

ACKNOWLEDGMENT

First of all, I would like to give my immensely thanks to God for blessing me with success during my study and also for granting me with strength, power and good health to reach my ambition.

I would like to express my gratitude and sincere thanks to my supervisor Prof. Dr. U.

Dr.U.E.Chaudhari, Head, Department of Chemistry, Mahatma Fule Art`s, Commerce and Sitaramji Chaudhari Science College, Warud, my guide and my mentor, for giving me an opportunity to work under his guidance and for encouraging me at each step during the duration of the Ph. D work with his valuable inputs and guidance.

I expressed my sincere thanks to Dr. J.D. Wadate, Principal, Mahatma Fule Art`s, Commerce and Sitaramji Chaudhari Science College, Warud, for granting me the permission to carry out my research work.

I also acknowledge my sincere thanks to Dr. R.P. Ganorkar, Associate Professor, Department of Chemistry, Mahatma Fule Art's, Commerce and Sitaramji Chaudhari Science College, Warud for their constant encouragement.

I am also thankful to my research colleagues Dr. Atul Wanjari, Mr. A.R. Bole, Dr.

I am also thankful to SEM In-charge, Department of Physics, Manipur University, Imphal for providing SEM facility. I am also thankful to Principal of Arts, Commerce and Science College, Kiran Nagar Amravati for providing FTIR facility.

I also would like to thanks Mr. Prashant Alone Lab Assistant, Mr. Ravindra K. Bhoyar, Mr. Ashok C. Bawne, Mr. Mohan Sonare lab attendant, non-teaching staff of Chemistry Department, for their help and co-operation.

I am deeply indebted to Shri. Rameshwar Narayanrao Somwanshi my father, Sau. Shakuntala Rameshwar Somwanshi

my mother, Sau. Jaya Anil Somwanshi my wife, Mr. Rupesh Shekar my friend and my family members for their constant encouragement and support throughout my entire research work.

I acknowledge sincerely with great pleasure the help rendered by my all teachers, colleagues and dears and nears who helped me directly and indirectly during the completion of this work.

Dr. Anil Rameshwar Somwanshi

M.Sc.SET,NET,Ph.D.

CONTENT

RAMAN-2022
2nd International Conference on Recent Advances in Material Science and Nanotechnology
In Association with International Journal of Scientific Research in Science and Technology
Volume 9 | Issue 13 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

To Study the Adsorption Efficiency of Pb (II) from Aqueous Solution Using Low-Cost Adsorbent

Anil R. Somwanshi
Department of Chemistry, J.D. Patil Sangludkar Mahavidyalaya, Daryapur, Maharashtra, India

ABSTRACT
Lead is toxic to living systems and therefore it is essential to remove it from wastewater.The removal of Lead (II) ions from aqueous solution by using Phyllanthus emblica tree bark was investigated. Adsorption studies were performed by batch experiments. The effect of contact time, pH, adsorbent dose and temperature were explored. From the experimental data, the isotherm parameters of Freundlich and Langmuir were calculated. The equilibrium was best represented by the Langmuir. Langmuir adsorption capacity (Qo) was found to be3.28 mg/g.

Keywords: Adsorption, Lead (II),Langmuir, Freundlich

I. INTRODUCTION

Many heavy metal ions are present in the form of pollutants in industrial effluent.Ground water and surface water gets contaminated by heavy metal ions released from the industries such as metal plating, metal finishing, rubber processing, fertilizers, mining etc[1-2]. Rapid industrialization has led to increased disposalof heavy metals into the environment. The Groundwater that contains an appreciable amount of iron or manganese or both is always devoid of dissolved oxygen and high in carbon dioxide content[3]. As far as is known, humans suffer no harmful effects from drinking water containing lead. However, lead interferes with laundering operation, imparts objectionable stains to plumbing fixture, and causes trouble in distribution systems by supporting growths of iron bacteria[4]. With better awareness of the problems associatedwith lead came an increase in research studiesrelated to methods of removing lead from wastewater,for which a number of technologies have beendeveloped over the years[5]. These technologiesinclude chemical precipitation, electro flotation, ionexchange, reverse osmosis and adsorption onto activatedcarbon. These methods are not cost-effectivein the Indian context. Low-cost and nonconventionaladsorbents include agricultural wastes,such as natural compost, Irish peat, planer shell, walnutshell, and biomass[6-7].

II. MATERIALS AND METHODS

Preparation of Adsorbent

Phyllanthus emblica bark were collected from the Mahendri Forest region. It was wash with triple distilled water to remove impurities from it and then sundried for 4 days. Later on, the bark was cut in to small pieces with the mesh size 100. To activate the adsorption power of adsorbent the bark was wash with 0.1 N H_2SO_4 and 0.1 N NaOH solution.

Preparation of Solutions

Standard solution of Leadwas prepared in deionised water. The concentration of Pb (II) was analysed by UV-Visible spectrophotometer (model-117) at the wavelength of 460 nm.

III. RESULTS

Effect of pH

The effect of pH can be done experimentally by taking 0.5 gm of adsorbent with working volume of Pb (II) 200 ml having constant initial metal ions concentration and the contact time of 3 hours with shaking speed 1000 rpm in the pH range 1 to 7 shown in fig.1.

Effect of Contact time

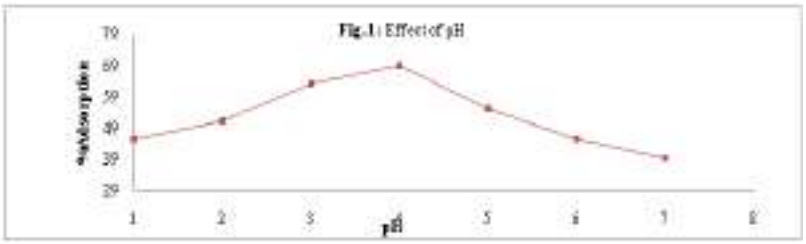
Study was carried out by taking 0.5 gm of adsorbent with working volume of Pb (II) 200 ml with known concentration of metal ions. It was observed that initially rate of adsorption is rapid up to 180 min with shaking speed 1000 rpm and then there was no further change in equilibrium concentration. Equilibrium time was found to be 300minutes for this adsorptionshown in fig.2.

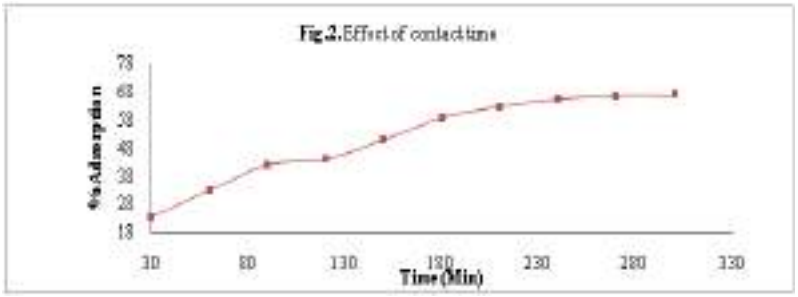
Effect of Adsorbent dose

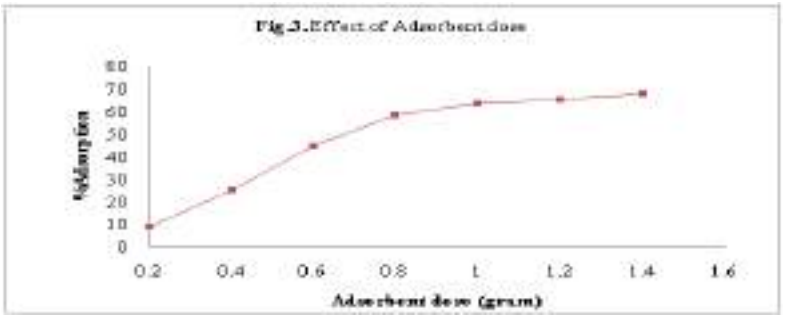
The effect of varying the adsorbent dosage (AC-PETB, AC- PETB-SLS and AC- PETB-AMPSA) from 0.2–1 gram for adsorption of Mn (II) from their aqueous solutions having known volume of initial concentration was studied at pH 4 It has been found that the percent removal of Mn (II) increases with increase in adsorbent dose up to some extent, thereafter further increase adsorbent dose shown in fig.3.

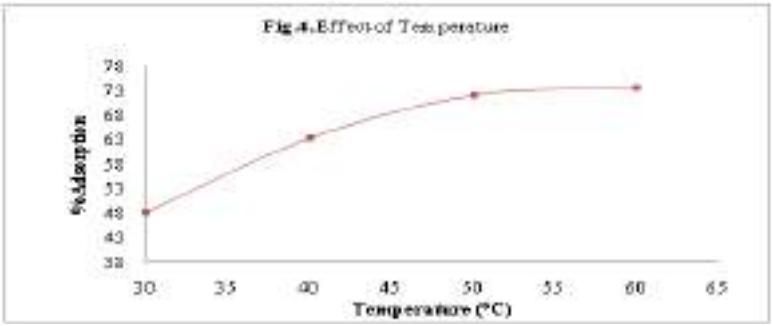
Effect of Temperature

Effect of temperature was studied by varying the temperature from 30°C to 60°C with working volume 200 ml having known concentration. Study was carried out at pH 4 and at 1000 rpm with contact time 3 hours shown in fig.4. As the temperature increases porosity increases and percent of adsorption increases up to certain extent and then remains constant this is due to chemisorptions process.









Isotherm Modelling

Langmuir Adsorption IsothermThe Langmuir isothermmodel can be given as:

$$\frac{1}{q_e} = \frac{1}{Q^0 b} \times \frac{1}{Ce} + \frac{1}{Q^0}$$

The Langmuir constant Q^o is a measure of adsorption capacity and b is the measure of energy of adsorption. In order to observe whether the adsorption is favourable or not, a dimensionless parameter 'R_L' obtained from Langmuir Isotherm. The values of Q^o and b were evaluated from the intercept and slope of linear plots of $1/q_e$ vs. $1/C_e$ respectively.

Freundlich Adsorption isotherm It is most commonly used adsorption isotherm model which describes adsorption on heterogeneous surfaces with interactions among adsorbed molecules. It helps to investigate the nature of adsorption and the adsorption capacity of an adsorbent. The linear form of Freundlich isotherm model is

$\log q_e = B. \log C_e + \log K_f$

Where, B and K_f are Freundlich constant. These constants represent the adsorption capacity and the adsorption intensity respectively. q_e is the amount adsorbed at equilibrium(mg/g), Ce is the equilibrium concentration of adsorbate.

Table 1: Adsorption Isotherm Constants

Metal ion	Langmuir Isotherm				Freundlich Isotherm		
	Q_o	b	R_L	R^2	K_f	1/n	R^2
Pb(II)	3.2820	0.2584	0.1492	0.999	1.544	0.025	0.999

IV. CONCLUSION

Tree bark prepared from *Phyllanthus emblica* shows good adsorption efficiency for the removal of lead (II). The removal efficiency was found to be rapid at initial stage and then slow down. The adsorption isotherm data was best revealed by the Langmuir adsorption isotherm where maximum adsorption capacity for the removal of Pb (II) was found to be 3.28 mg/g. The maximum removal efficiency was found to be at pH 4. Batch study indicatesthat as the temperature, adsorption dose, contact time increases adsorption capacity increases.

V. REFERENCES

[1]. A.K. Wanjari, Adsorption of manganese (II) by nitric acid treated granular activated charcoal prepared from Cordia Macleodii tree bark. Der Pharma Chemica. 2016, 8(18): 87-94.

[2]. Atul Wanjari et al, Removal of Cr(VI), Pb(II), Mn(II) and Bi(III) From Aqueous Solutions Using Granular Activated Charcoal Prepared From Cordia Macleodii Tree Bark. Rasayan Journal of Chemistry. 2017, 10(1): 82-85 http://dx.doi.org/10.7324/RJC.2017.1011556

[3]. Atul Wanjari, Evaluation of Adsorption Effiency of FerroniaElefuntum Fruit Shell for Rhodamine-B Retrieval from Aqueous Solution. International Journal Of Pharmaceutical And Chemical Sciences. 2013 2(1): 457-460.

[4]. U.E. Chaudhari et al, Adsorption, Kinetics and Equilibrium Studies on Removal of Mn (II) From Aqueous Solutions Using Surface Modified Granular Activated Charcoal as a Low-Cost Adsorbent. International Research Journal of Environment Sciences. 2016.5(12): 47-55.

[5]. A.K. Wanjari et al, Surface Modified Granular Activated Charcoal With Anionic Surfactant For Scavenging of Co(II) Metal Ions From Aqueous Solution : Themodyanamics and Kinetics. International journal of research in biosciences, agriculture & technology, 2015 special issue 3:93-99.

[6]. U.E. Chaudhari et al, Sodium Dodecyl Sulfate Impregnated Granulated Activated Charcoal for the Scavenging of Cr (VI) Metal Ions from Aqueous Solution, International Journal of Chemical and Physical Sciences, Vol. 4 Special Issue – NCSC Jan-2015, 261-266.

[7]. Atul K. Wanjari, Maheshkumar Prakash Patil, Umesh E. Chaudhari, Vaibhav N. Gulhane, Gun-Do Kim & Anley T. Kiddane (2022) Bactericidal and photocatalytic degradation of methyl orange of silver-silver chloride nanoparticles synthesized using aqueous phyto-extract, Particulate Science and Technology, DOI: 10.1080/02726351.2022.2056552

Certificate

This is to certify that Dr./Shri./Smt.: **Dr. Anil Rameshwar Somwanshi** has successfully published his/her book titled:- **Adsorption Technique for Removed of Heavy Metal Ions** through Laxmi Book Publication with ISBN– 978-1-387-59195-4 in the Year **2022.**

Printed by
Laxmi Book Publication
258/34, Raviwar Peth,
Solapur, Maharashtra, India.
Contact No. : 9595359435
Website: http://www.lbp.world
Email ID: apiguide2014@gmail.com

Published by
Lulu Publication
Hillsborough St, Raleigh,
United States of America (USA).

Authorized Signature
Laxmi Book Publication

IJSRST

2nd International Conference on Recent Advances in Material Science and Nanotechnology
In Association with International Journal of Scientific Research in Science and Technology
Volume 9 | Issue 13 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)

To Study the Adsorption Efficiency of Pb (II) from Aqueous Solution Using Low-Cost Adsorbent

Anil R. Somwanshi

Department of Chemistry, J.D. Patil Sangludkar Mahavidyalaya, Daryapur, Maharashtra, India

ABSTRACT

Lead is toxic to living systems and therefore it is essential to remove it from wastewater.The removal of Lead (II) ions from aqueous solution by using Phyllanthus emblica tree bark was investigated. Adsorption studies were performed by batch experiments. The effect of contact time, pH, adsorbent dose and temperature were explored. From the experimental data, the isotherm parameters of Freundlich and Langmuir were calculated. The equilibrium was best represented by the Langmuir. Langmuir adsorption capacity (Qo) was found to be3.28 mg/g.

Keywords: Adsorption, Lead (II),Langmuir, Freundlich

I. INTRODUCTION

Many heavy metal ions are present in the form of pollutants in industrial effluent.Ground water and surface water gets contaminated by heavy metal ions released from the industries such as metal plating, metal finishing, rubber processing, fertilizers, mining etc[1-2]. Rapid industrialization has led to increased disposalof heavy metals into the environment. The Groundwater that contains an appreciable amount of iron or manganese or both is always devoid of dissolved oxygen and high in carbon dioxide content[3]. As far as is known, humans suffer no harmful effects from drinking water containing lead. However, lead interferes with laundering operation, imparts objectionable stains to plumbing fixture, and causes trouble in distribution systems by supporting growths of iron bacteria[4]. With better awareness of the problems associatedwith lead came an increase in research studiesrelated to methods of removing lead from wastewater,for which a number of technologies have beendeveloped over the years[5]. These technologiesinclude chemical precipitation, electro flotation, ionexchange, reverse osmosis and adsorption onto activatedcarbon. These methods are not cost-effectivein the Indian context. Low-cost and nonconventionaladsorbents include agricultural wastes,such as natural compost, Irish peat, planer shell, walnutshell, and biomass[6-7].

II. MATERIALS AND METHODS

Preparation of Adsorbent

Phyllanthus emblica bark were collected from the Mahendri Forest region. It was wash with triple distilled water to remove impurities from it and then sundried for 4 days. Later on, the bark was cut in to small pieces with the mesh size 100. To activate the adsorption power of adsorbent the bark was wash with 0.1 N H_2SO_4 and 0.1 N NaOH solution.

Preparation of Solutions

Standard solution of Leadwas prepared in deionised water. The concentration of Pb (II) was analysed by UV-Visible spectrophotometer (model-117) at the wavelength of 460 nm.

III. RESULTS

Effect of pH

The effect of pH can be done experimentally by taking 0.5 gm of adsorbent with working volume of Pb (II) 200 ml having constant initial metal ions concentration and the contact time of 3 hours with shaking speed 1000 rpm in the pH range 1 to 7 shown in fig.1.

Effect of Contact time

Study was carried out by taking 0.5 gm of adsorbent with working volume of Pb (II) 200 ml with known concentration of metal ions. It was observed that initially rate of adsorption is rapid up to 180 min with shaking speed 1000 rpm and then there was no further change in equilibrium concentration. Equilibrium time was found to be 300minutes for this adsorptionshown in fig.2.

Effect of Adsorbent dose

The effect of varying the adsorbent dosage (AC-PETB, AC- PETB-SLS and AC- PETB-AMPSA) from 0.2–1 gram for adsorption of Mn (II) from their aqueous solutions having known volume of initial concentration was studied at pH 4 It has been found that the percent removal of Mn (II) increases with increase in adsorbent dose up to some extent, thereafter further increase adsorbent dose shown in fig.3.

Effect of Temperature

Effect of temperature was studied by varying the temperature from 30°C to 60°C with working volume 200 ml having known concentration. Study was carried out at pH 4 and at 1000 rpm with contact time 3 hours shown in fig.4. As the temperature increases porosity increases and percent of adsorption increases up to certain extent and then remains constant this is due to chemisorptions process.

Fig.2.Effect of contact time

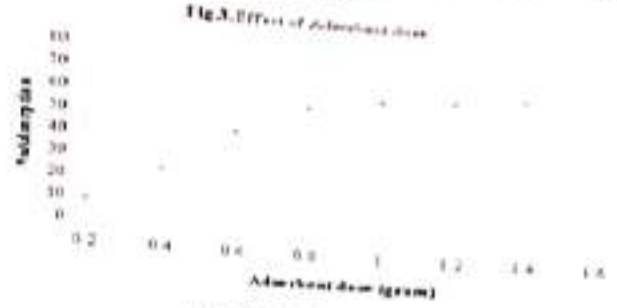


Fig.3.Effect of Adsorbent dose

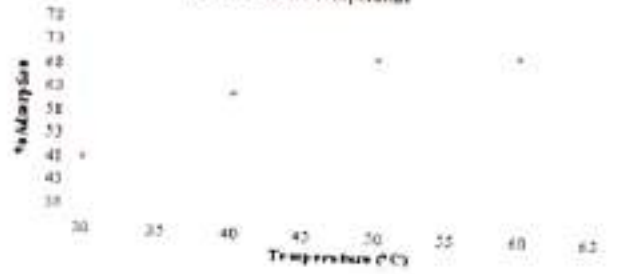


Fig.4.Effect of Temperature

Isotherm Modelling

Langmuir Adsorption IsothermThe Langmuir isothermmodel can be given as:

$$\frac{1}{q_e} = \frac{1}{Q^0 b} \times \frac{1}{Ce} + \frac{1}{Q^0}$$

The Langmuir constant Q^0 is a measure of adsorption capacity and b is the measure of energy of adsorption. In order to observe whether the adsorption is favourable or not, a dimensionless parameter 'R_L' obtained from Langmuir Isotherm. The values of Q^0 and b were evaluated from the intercept and slope of linear plots of $1/q_e$ vs. $1/C_e$ respectively.

Freundlich Adsorption isotherm It is most commonly used adsorption isotherm model which describes adsorption on heterogeneous surfaces with interactions among adsorbed molecules. It helps to investigate the nature of adsorption and the adsorption capacity of an adsorbent. The linear form of Freundlich isotherm model is

$\log q_e = B. \log C_e + \log K_f$

Where, B and K_f are Freundlich constant. These constants represent the adsorption capacity and the adsorption intensity respectively. q_e is the amount adsorbed at equilibrium(mg/g), Ce is the equilibrium concentration of adsorbate.

Table 1: Adsorption Isotherm Constants

Metal ion	Langmuir Isotherm				Freundlich Isotherm		
	Q_o	b	R_L	R^2	K_f	1/n	R^2
Pb(II)	3.2820	0.2584	0.1492	0.999	1.544	0.025	0.999

IV. CONCLUSION

Tree bark prepared from *Phyllanthus emblica* shows good adsorption efficiency for the removal of lead (II). The removal efficiency was found to be rapid at initial stage and then slow down. The adsorption isotherm data was best revealed by the Langmuir adsorption isotherm where maximum adsorption capacity for the removal of Pb (II) was found to be 3.28 mg/g. The maximum removal efficiency was found to be at pH 4. Batch study indicatesthat as the temperature, adsorption dose, contact time increases adsorption capacity increases.

V. REFERENCES

[1]. A.K. Wanjari, Adsorption of manganese (II) by nitric acid treated granular activated charcoal prepared from Cordia Macleodii tree bark. Der Pharma Chemica. 2016, 8(18): 87-94.

[2]. Atul Wanjari et al. Removal of Cr(VI), Pb(II), Mn(II) and Bi(III) From Aqueous Solutions Using Granular Activated Charcoal Prepared From Cordia Macleodii Tree Bark. Rasayan Journal of Chemistry. 2017, 10(1): 82-85 http://dx.doi.org/10.7324/RJC.2017.1011556

[3]. Atul Wanjari. Evaluation of Adsorption Effiency of FerroniaElefuntum Fruit Shell for Rhodamine-B Retrieval from Aqueous Solution. International Journal Of Pharmaceutical And Chemical Sciences. 2013 2(1): 457-460.

[4]. U.E. Chaudhari et al, Adsorption, Kinetics and Equilibrium Studies on Removal of Mn (II) From Aqueous Solutions Using Surface Modified Granular Activated Charcoal as a Low-Cost Adsorbent. International Research Journal of Environment Sciences. 2016.5(12): 47-55.

[5]. A.K. Wanjari et al, Surface Modified Granular Activated Charcoal With Anionic Surfactant For Scavenging of Co(II) Metal Ions From Aqueous Solution : Themodyanamics and Kinetics. International journal of research in biosciences, agriculture & technology, 2015 special issue 3:93-99.

[6]. U.E. Chaudhari et al, Sodium Dodecyl Sulfate Impregnated Granulated Activated Charcoal for the Scavenging of Cr (VI) Metal Ions from Aqueous Solution. International Journal of Chemical and Physical Sciences, Vol. 4 Special Issue – NCSC Jan-2015, 261-266.

[7]. Atul K. Wanjari, Maheshkumar Prakash Patil, Umesh E. Chaudhari, Vaibhav N. Gulhane, Gun-Do Kim & Anley T. Kiddane (2022) Bactericidal and photocatalytic degradation of methyl orange of silver-silver chloride nanoparticles synthesized using aqueous phyto-extract, Particulate Science and Technology, DOI: 10.1080/02726351.2022.2056552

Online Education : Myths and Facts

Dr. Hemlata Ganeshrao Dhage
Mr. Sunil Rambhau Thorat
Dr. Sanjay Pandurang Kale

IIP

Contents

Impact of Online Courses on Education

Mangalavati G. Pandey
J. D. Patil Sangludkar Mv. Darayapur. Dist. Amravati
Pin Code 444803
pandeymg08@gmail.com

Abstract

Online learning is one of the new innovative study methods that have been introduced in the pedagogy field. In the last few years, there has been a great shift in the training methods. students can now learn remotely using the internet and computers.

Online learning comes in many forms and has been developing with the introduction of new technologies. Most of the universities, high schools and other institutions in the world have all instituted this form of learning and the student population in the online class is increasing fast. There has been a lot of research on the impacts of online education as compared to the ordinary classroom education.

There are considerable differences between the online learning environment and classroom environment. In the online environment, teachers and pupils don't meet physically as opposed to the classroom environment where teachers and pupils interact physically. In this study, the impact of the online learning on the students, teachers and institutions involved was examined.

Thesis Statement / Hypothesis

The thesis statement for this study is: "online learning has positive impact on the learners, teachers and the institution offering these courses"

Background study

Online learning or E learning is a term used to describe various learning environments that are conducted and supported by the use of computers and the internet. There are a number of definitions and terminologies that are used to describe online learning.

These include: E learning, distance learning, computer learning among others (Anon, 2001). Distant learning is one of the terminologies used in E learning and encompasses all learning methods that are used to train students that are geographically away from the training school. Online learning on the other hand is used to describe all the learning methods that are supported by the internet (Moore *et al.*, 2011).

प्राचार्य
जे.डी. पाटील सांगळूदकर महाविद्यालय,
दर्यापूर

Another terminology that is used is E learning which has been described by most authors as a learning method that is supported by the use of computers, web enabled communication and the use of new technological tools that enhance communication (Spector, 2008). Other terminologies that are used to describe this form of online learning are virtual learning, collaborative learning, web based learning and computer supported collaborative learning (Conrad, 2006).

Impacts of online education

Various studies and articles documents the merits, demerits and challenges of online studies. These studies show that online study is far beneficial to the students, teachers and the institution in general and that the current challenges can be overcome through technological advancement and increasing efficiency of the learning process.

One of the key advantages of online learning is the ability of students to study at their own comfort. For a long time students had to leave their comfort areas and attend lecturers. This change in environment causes lack of concentration to students, In contrast, E-learning enables the students to choose the best environment for study and this promotes their ability to understand. As a result, students enjoy the learning process as compared to the conventional classroom learning. Online education is an amenable instructional delivery process that includes any learning that takes place via the internet. Online learning enables educators to communicate with students who may not be capable of enrolling in a traditional classroom course and assists students who need to work on their own schedule and at their own speed. Online education refers to the type of knowledge which is imparted through the internet. Millions of people globally are enrolled in online courses and can learn from the comfort of their homes. Online education can come in different ways; they could be educational webinars and videos on the internet or even face to face learning on the laptop with the teacher, which utilises the internet. Online education contributes a myriad of advantages for people, as well as companies because it provides flexibility among other work. This indicates that despite people's physical locations, they can accomplish the same level of education by taking similar online courses

Another benefit is time and cost saving. Online students are able to study at home and this saves them the travel and accommodation costs. This is in contrast with the classroom environment where learners have to pay for transport and accommodation costs as well as any other costs associated with the learning process.

Online study has been found to reduce the workload on the tutors. Most of the online notes and books are availed to the students and this reduces the teacher's workload. Due to the availability of teaching materials online, tutors are not required to search for materials. Teachers usually prepare lessons and this reduces the task of training students over and over again.

Accessibility to learning materials is another benefit of online learning. Students participating in online study have unlimited access to learning materials and this makes them have the ability to study effectively and efficiently. On the other

hand, students in the classroom environment have to take notes as the lecture progress and these notes may not be accurate as compared to the materials uploaded on the websites.

Unlimited resources are another advantage of online study. Traditionally, learning institutions were limited on the number of students that could study in the classroom environment. The limitations of facilities such as lecture theaters and teachers limited the student enrollment in schools (Burgess & Russell, 2003).

However, with the advent of online studies, physical limitations imposed by classrooms, tutors and other resources have been eliminated. Vast number of students can now study in the same institution and be able to access the learning materials online. The use of online media for training enables vast number of students to access materials online and this promotes the learning process.

Promoting online study has been found by most of the resechers to open the students to vast resources that are found on the internet. Most of the students in the classroom environment rely on the tutors notes and explanations for them to understand a given concept.

However, student using the web to study at most of the time are likely to be exposed to the vast online educational resources that are available. This results to the students gaining a better understanding of the concept as opposed to those in the classroom environment (Berge & Giles, 2008).

Online study environment allows tutors to update their notes and other materials much faster as compared to the classroom environment. This ensures that the students receive up to date information on a given study area.

One of the main benefits of E-learning to institutions is the ability to provide training to large number of students located at any corner of the world. These students are charged training fees and this increases the money available to the institution. This extra income can be used to develop new educational facilities and these will promote the education further (Gilli *et al.*, 2002).

Despite the many advantages that online study has on transforming the learning process, there are some challenges imposed by the method. One of the challenges is the technological limitations of the current computers which affect the quality of the learning materials and the learning process in general.

Low download speed and slow internet connectivity affects the availability of learning materials. This problem is however been reduced through the application of new software and hardware elements that have high access speeds. This makes it easier to download leaning materials and applications. As the computing power increases, better and faster computers are being unveiled and these will enable better access to online study facilities.

Another disadvantage of online learning as compared to the classroom environment is lack of feedback from the students. In the classroom environment, students listen to the lecture and ask the tutors questions and clarifications of any issues they didn't understand. In the online environment, the response by the teacher may not be immediate and students who don't understand a given concept may find it hard to liaise with the teachers.

The problem is however been circumvented by the use of simple explanation methods, slideshows and encouraging discussion forums between the teachers and students. In the discussion forums, students who don't understand a concept can leave a comment or question which will be answered by the tutor later.

Advantages of Online Education

Online education enables us to learn from various mentors and teachers in different areas, increasing our knowledge and perspective. It reduces nervousness among students, as many are able to communicate more through online education than regular classes. One can learn from merely anyplace as long as they have an available internet device.

Online education normally provides a chance to study at our own speed as there is no rush. Most online courses are usually enjoyable and more comfortable compared to attending traditional classes. It spares you the inconvenience of having to travel to a particular destination every single day.

Online education usually is more affordable. Online education further happens to be comparatively cheaper in comparison to conventional educational approaches. Under traditional university programs, the students are required to compensate for transportation, textbooks, institutional facilities such as gyms, libraries, swimming pools, and other costs that expedite the cost of university education up. Online education, on its part, charges only for tuition and additional essential expenses. Virtual education thus offers both the wealthy and the poor an opportunity.

It allows one to learn innovative approaches through the internet and therefore become more skilful. In online education, if there are any varintions in the syllabus, updates can be done instantly compared to conventional means of education.

Online education is flexible and adaptable since one can study at any time, even at midnight. It can help increase the grades of some people as compared to standard traditional education. Some people learn more through online education.

There is no need to wait for office hours to speak to the instructor; you can immediately access them through chat or email. There is considerably a large amount of educational information on the internet. Online education can also help one to be in the mix of a diverse group of people from varied educational, social, cultural and philosophical backgrounds. The subject matter is always available on the internet, unlike traditional education.

Disadvantages of Online Education

The advantages that online education brings to students are immense and indisputable. Pursuing an online course is an excellent option in education, particularly when traditional learning situations have many obstacles, such as commuting or distance. However, as everything has two sides, online education also has some fundamental drawbacks that can be inconvenient.

Using the computer too much can make the students prone to plagiarism. It can also cause vision problems as we sit near the laptop almost the whole day. Online education may also hinder physical development. Online education can be quite complicated for a person to be accountable for their own learning without someone to drive them to do something.

Online education detaches you from your classmates. One might need to put in extra time in some cases to understand the learning process. It is easier to cheat in an online exam than when in a class and hence may not be advisable during exams. Online education also gives one a lot of autonomy which may be critical for our learning. There are a number of distractions on the internet through adverts, and this might interrupt our learning. Online education also has significantly less self-assessment.

Like any other form of learning, online studies have a number of benefits, and challenges. It is therefore not logical to discredit online learning due to the negative impacts of this training method. Furthermore, the benefits of e-learning far outweigh the challenges.

Conclusion

In culmination, a comparative study between classroom study and online study was carried out. The study was done by examining the findings recorded in books and journals on the applicability online learning to students. The study revealed that, online learning has many benefits as compared to the conventional learning in the classroom environment.

Though online learning has several challenges such as lack of feedback from students and lack of the proper technology to effectively conduct online learning, these limitations can be overcome by upgrading the E-Leanning systems and the use of online discussion forums and new web based software's.

In conclusion, online learning is beneficial to the students, tutors and the institution offering these courses. I would therefore recommend that online learning be implemented on all learning institutions and research on how to improve this learning process should be carried out. Online education has both advantages and shortcomings, but it is an excellent method of learning that can help develop a student's performance. To succeed in online education, one should choose an ideal

university and course to avoid pursuing education from among the various suspicious universities that employers may reject. The other most essential thing is to assure that one needs to maintain communication with the school faculty and fellow students. The important point is proper time administration that helps one manage our time to complete and submit prescribed assignments in time.Online education's potential advantages involve increased educational access; it provides a high-quality learning opportunity, improves student outcomes and skills, and expands educational choice options. Therefore, location, time, and quality are no longer considered factors in seeking degree courses or higher education because of online education.

References

[1] Anon, C. (2001). E-learning is taking off in Europe. *Industrial and Commercial Training, 33* (7), 280-282

[2] Berge, Z., & Giles, L. (2008). Implementing and sustaining e-learning in the workplace. *International Journal of Web-Based Learning and Teaching Technologies, 3*(3), 44-53.

[3] Burgess, J. & Russell, J. (2003).The effectiveness of distance learning initiatives in organizations. *Journal of Vocational Behaviour*, 63 (2),289-303.

[4] Conrad, D. (2006). *E-Learning and social change. Perspectives on higher education in the digital age*. New York: Nova Science Publishers.

[5] Gilli, R., Pulcini, M., Torchia, S. & Zavagno, M. (2002). E-learning: A strategic Instrument. *International Journal of Business Performance Management*, 4 (1), 2-4.

[6] Moore, J. L., Camille, D. & Galyen, K. (2011). E-Learning, online learning and distance learning environments: Are they the same? *Internet and Higher Education*, 14(1), 129-135.

[7] Spector, J., Merrill, M., Merrienboer, J. & Driscoll, M. P. (2008). *Handbook of research on educational communications and technology (3rd ed.)*. New York: Lawrence Erlbaum Associates.

Publication Certificate

Awarded To

"

SSGP

In recognition of the publication of
Research Paper/Article/Chapter

in Multidisciplinary Edited Book Titled

"Exuberant Research"

ISBN : 978-93-91773-06-9

Dr. Rashmi Singh
Editor

Dr.Afzal Mukhtar
Editor

Shree Siddhivinayak
Global Publication

ISBN: 978-93-91773-06-9

Price: 399/-

Publishing Year 2022

Published and printed by:

Shree Siddhivinayak Global Publication

Office Address: E-5, Office No.8, Highland Park,
Mumbai 400082, Maharashtra

Email: ssglobalpublication@gmail.com

Exuberant Research ISBN: 978-93-91773-06-9

USE OF RESEARCH TOOLS AND SOFTWARE IN BUSINESS RESEARCH

Mangalavati G. Pandey
J. D. Patil Sangludkar Mv.
Darayapur.Dist. Amravati

Abstract
Research is a tool of building block and a sustaining pillar of every discipline scientific or otherwise that one knows of. Before comprehending the true meaning of the term, we would like to make it clear that this is primarily focuses on the process of business research. The premise of this decision-oriented enquiry is vast and may range from the simplistic view, which involves compilation and validation of information, to an exhaustive theory and model construction.
Business to Business (B2B) is a transaction which occurs between two companies, that is to say, the consumer is not involved in the transaction of a company. The term may also refer to the total information of the company that provides goods or services to another company.

Tools and software used in BUSINESS-TO-BUSINESS research

Desk Research
Desk research is used to collect secondary data which is collected from previous research. Most research is published in electronic copy or hard copy of the research. Libraries, online databases and internet are important sources of the desk research.

Internet Research
Internet research tool is growing rapidly in the industrial market and e-intelligence is important in Business-to-Business research. It is used to find all the material and new findings of a research.

Qualitative Research
In this research there are three techniques used; they are focus groups, depth interviews and e-focus groups.

1. Focus groups: - It is a method using in qualitative research. It is a type of group discussion. In this participant are involved in debate or in discussions of a market for a product. The participants make comment or suggestions of a market they have scrutinised to the subject and the other participants have to confirm or reject the comment. In this the focus groups understand the motivations and prejudices of the participants. Focus groups have four key characteristics.

i) All participants are actively involved.
ii) The people have experience in the field of research.
iii) The researchers provide depth qualitative data
iv) Discussions will help the researchers understand what is going on the market.

i. Focus groups are small groups with five to ten people involved. The participants have diverse experience in the field and interaction allows all members to speak. In larger groups there is little time and opportunity to for discussion. Therefore small groups are better suited and obtain a small pool of ideas.

ii. The commonality of experience is crucial in order to find the people who give correct information to the research. In this the people are selected on the basis of their degree of homogeneity, recruitment, and their ability to attend all the groups.

iii. Depth information provides qualitative data which does not have numerical value. The data is presented in words, diagrams and symbols etc. The data will be presented by the researcher to the group. The moderator of the group or researcher will guide the group to get the discussions for getting more ideas, attitudes and experiences. It is having more important preferences than group interviews. In this the key factor of this methodology is interaction between the group members.

iv. The topic discussion is important in the focus group. Questions are given to the group participants to start the discussion in a comfortable manner to give ideas and experiences on the topic to research.

2. Depth Interviews

Depth interviews are conducted for differing data collection in research and take the form of traditional appointment in personal interviews about the research. Nowadays, telephone or web interviews are common. It is a time extended depth interview. In this the participants contact by phone or net for several days on the research. From this the researcher will consider the information in questions and stimuli of the interview. Again the researcher expresses them to follow up the interview.

3. E-focus groups

Online focus groups are the new innovation in taking the qualitative research methods. Technological advances help to conduct the market research when it can be difficult to interview groups. In the Business To Business group the e-focus is becoming popular in the market because they are offering many things. In e-focus group it is easy to conduct research because there is no need to transcribe or manually record the discussions because it is captured electronically. Online groups are more cost effective than traditional methods in viewing the rental, transportation and transcribing expenses. In this we can find some benefits through e-focus groups they are

i. Participants and researchers are participating in group from their offices or houses without travelling to the specific venue.

ii. Researchers can watch the views of the groups online and send the messages and directions to influence the topic through the moderator without disturbing the group session.

iii. In this the participants can participate throughout the world from their respective places. There is no need to come to the venue.

Quantitative Research

Quantitative Research is used to measure the market, calculating the measurement of the market size and qualifying the measurement of the data. In this the data is in market share, market segmentations, penetration, distribution levels and growth rate of the market.

In this research there are three techniques are used. They are CATI Interviews, sampling and e-surveys.

1. CATI Interview

CATI stands for Computer Assisted Telephonic Interview. In this research telephone is playing an important role in the Business To Business market and it is easy to solve the large scale quantitative projects. From this we have many benefits. They are

I) From this interview we can reduce the interview error through navigating the data and increasing the accuracy of the data.

II) From this we will get immediate feedback of the data.

III) Getting more productivity with the lower cost.

IV) Complete the project rapidly, in a short period of time.

V) We are managing the quotas and multiple languages with great accuracy.

2. Sampling

Sampling is a technique of selecting a suitable sample or gathering the information from the population by taking different parameters and considerations into account. In sampling the researchers use the rules of random sampling to applying for the consumer surveys in Business To Business research. In this sampling some researchers argue that '- as a rule of thumb-' in Business To Business surveys that all the samples are relative to the lower sample size because the researchers or consumers see the target market as comparable to the structured environments and on similar criteria they make decisions on it. In this fewer survey responses to see that the same pattern that to relevant to the rest of the target market. This process is controversial, and may be strongly influenced by the structure of the organisation. In this case it is easy to understand the study concentration of market. In Business To Business research there is homogeneity between constructing the consumer market and consumer type sampling method are used. One advantage in this sampling is collecting the data in random sampling or error in the result to calculate mathematically. Random sampling is expensive because it requires the list of the companies involved in the research for selection. From this the researcher chooses to take multi stage sampling. In multi stage sampling the companies is listed into separate groups which have different characteristics in common. These company groups are known as stratum companies. The strata group companies are also having same and it is based of selecting the "quota" sample. From this the researchers select the companies in the process of quota or proportions from the stratum group companies to carry out.

3. E-surveys

In the past, web surveys were a very expensive methodology and slower for self completion than the postal surveys. With advances in technology it is preferable to collect data through web survey to evaluate the satisfaction of customer and staff. This provides product and service feedback immediately and it is evaluated in many Business To Business markets.

All researchers prefer to web surveys because it saves the time, cost and getting the accuracy of the data through levels in automatic routing.

At present e-surveys are done by the email invitations. From this we have to check the basic requirements of the survey.

i. The researcher should have the accurate and quality of email address list.

ii. The researcher has to see the audiences are using their computers and internet in their day to day working environment.

iii. The format of the survey should be a questionnaire type and it should be completed in ten minutes of time only.

From this survey the customers are answered to this survey then online survey is right technique for collecting the data.

This investigation has given an overview of the different tools and techniques used in research in the discipline of Business To Business marketing. It has looked at different methodological approaches and commented on their advantages and disadvantages.

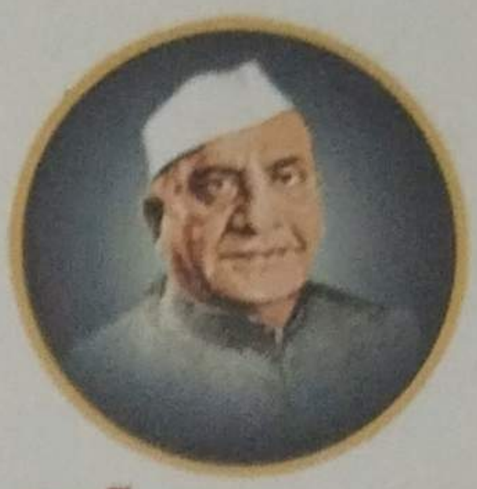
Conclusion

The most important and difficult task of a researcher is to be objective and neutral as possible. The temptation to skew the results in the hypothesized direction has to be avoided at all costs. Magazine articles and newspaper surveys which want to prove a point might want to skew the opinion polls in favour of the Capitalists or the Republicans, or on the need for reservation versus no reservation in educational institutes but a researcher has to collect and display the findings of the research as objectively as possible.

Whatever the research may be, it is essential to collect the sources and equipments according to the subject. Likewise, the appropriate handling of there sources is also vital. Therefore that research depends on the research's work. At the same time to draw a conclusion through the use of subtle & clever interviewing skill as per appropriate time or conditions is also vital. There should not be any exaggeration through the questions so that the conclusion should be derived by asking relevant questions to the interviewer.

References

1. Doing Social Research : Leonard Cargan
2. Research Methodology "Concepts and Cases" : Deepak Chawala
3. Research Methodology : Kayande, Patil
4. Scientific Research Methodology : Dr. Ranade
5. Operation Research : R. Panneerstvam
6. Research Methodology : J. A. Khan
7. Technique and Trends in Research : V. V. Khanzode
8. Methods and Techniques of Research : C. R. Kothari



Shri Shivaji Education Society Amravati's

J. D. Patil Sangludkar Mahavidyalaya,

Daryapur, Dist.Amravati.

Accredited by NAAC with 'B' Grade in 2nd Cycle

A One Day National Conference on

PRESENT SCENARIO OF CLASSICAL & SEMI CLASSICAL FORMS OF MUSIC

Chief Editor

Dr. Vrushali R. Deshmukh
Asst. Prof. Dept. of Music,
J. D. Patil Sangludkar Mahavidyalaya,
Daryapur, Dist.Amravati.

Peer Reviewed Refereed and UGC Listed Journal (Journal No. 47026)

ISSN 2319 - 359X

AN INTERNATIONAL MULTIDISCIPLINARY HALF YEARLY RESEARCH JOURNAL

IDEAL

Volume - X, Issue - II,
March - August - 2022
Hindi Part - I

IMPACT FACTOR / INDEXING
2020 - 6.008
www.sjifactor.com

Ajanta Prakashan

CONTENTS OF HINDI PART - I

VOLUME - X, ISSUE - II - MARCH - AUGUST - 2022
IDEAL - ISSN - 2319 - 359X - IMPACT FACTOR - 6.008 (www.sjifactor.com) AP - 7

२१. महाराष्ट्र का लोकगीत: गोंधळ

डॉ. मृणाल प्रभाकरराव कडू
जे. डी. पाटील संगळुदकर महाविद्यालय, दर्यापूर ।

देश - प्रदेश की पाहचान, वहाँ की भौगोलीक स्थिती, वातावरण, जनजीवन आदि का प्रभाव लोकगीतों पर पड़ता हैं। अतः लोकगीतों को 'प्रदेश की संस्कृति का दर्पण' कहाँ जाता हैं। मानव - मन की अभिव्यक्ति सुरीली लोकगीतों में मुखारित होतीं हैं। इन्हीं सारी विशेषताओं से विभिन्न प्रान्तों के लोकगीत वैविध्यपूर्ण दिखाई देते हैं।

महाराष्ट्र की संस्कृति भारतीय संस्कृति यह में अपना महत्वपूर्ण स्थान रखती हैं। महाराष्ट्र की लोकगीतों की अभिव्यंजना में आवेग, मार्मिकता, प्रवाह सहजता एवं स्वाभाविकता हैं। महाराष्ट्र में सभी जाती धर्म के लोग रहते हैं, इन सभी धर्म के लोगोंके त्योंहार अलग - अलग हैं जैसे - दिपावली, दशेरा, होली, गणेश उत्सव, नवरात्री, ईद, ख्रिसमस आदि। महाराष्ट्र में विविध जाती - धर्म - सम्प्रदायों के लोग एक साथ मिलजुलकर रहते हैं और इन सभी के लोकगीतों में भी विविधता पायी जाती हैं जैसे - पोवाड़ा, किर्तन, गौलन, भारुड़, तमशा, लावणी, गोंधळ जागरण आदि।

संशोधन की आवश्यकता

आज कल परिस्थिति बदल रही हैं, युग बदल रहा हैं और परिवर्तन की होड़ मची हुई हैं। वातावरण और पर्यावरण आदि सभी में परिवर्तन हो रहीं हैं। इस बिकट परिस्थिति में आज के आधुनिक युवा को अपनी सांस्कृतिक धरोहर को संजोगकर रखने के लिए प्रयास करने चाहिए और अपनी लोक - संस्कृति को व्यवहार में लाने के लिए भी प्रयास करने चाहिए । आज का युवा कल वृद्ध होगा। गोंधळ रूपी 'कला ' आज जीन वृद्धों के कंठ में हैं , कल आनेवाले वृद्ध अपनी ही कला के लिए मोहोताज़ हो जायेंगे। प्रस्तुत शोध - निबन्ध में ' महाराष्ट्र का लोकगीत गोंधळ ' का विवेचन करने का प्रयास कर रहीं हूँ।

महाराष्ट्र यह संतों और देवी - देवताओं की भूमि है। यहाँ देवी - देवताओंकी पूजाअर्चा और आराधना की जाती हैं। इनको प्रसन्ना करने के लिए विविध गीतों का एवं प्रार्थनाओं का प्रयोग किया जाता हैं। जैसे रेणुका देवी और तुळजाभवानी देवी आदि देवताओंकी आराधना के लिए और देवी के महात्म्य पर काव्य , उनके पराक्रम की कथाओं का गायन जीन गीतों में किया जाता हैं उसे गोंधळ कहाँ जाता हैं।

महाराष्ट्र के लोकजीवन में गोंधळ का स्थान महत्वपूर्ण हैं। गोंधळ की परम्परा प्राचीन काल से चली आ रहीं हैं। 'गोंधळी 'रेणुका देवी के भगत (भक्त) होते हैं। रेणुका देवी के अस्तित्व के साथ ही गोंधळ का अस्तित्व होना चाहिए ऐसा कहा जाता हैं।

कर्नाटक का 'गोंदल 'नामक कुलाचार और महाराष्ट्र का 'गोंधळ 'इनमे साम्य पाया जाता हैं। इस साम्य से कर्नाटक का 'गोंदल 'और महाराष्ट्र का 'गोंधळ 'प्रादेशिक लोकजीवन के भिन्नता के साथ समकालीन होना चाहिए। कर्नाटकी 'गोंदल 'परम्परा का उल्लेख ७ वी सदी में कर्नाटक के वाङमय में मिलता हैं।

महाराष्ट्र में 'गोंधळ' की परम्परा का उल्लेख ७ वी सदी के पूर्व मानी जाती हैं। इसका प्रथम उदय महाराष्ट्र में हुआ और आगे उसका प्रचार कर्नाटक में होकर गोंधळ का रूपांतरण गोंदल में हुआ। गोंधळी (गोंधळ इस गीतप्रकार का गायन करने वाला) तुलजाभवानी और रेणुका देवी के उपासक हैं। गोंधळ का सम्बंध 'भूतमाता 'देवी से लगाया जाता हैं। 'भूतमातृ महोत्सव 'में गोंधळ का प्रस्तुतीकरण ७ वीं सदीं से १३ वीं सदीं तक किया जाता था।

गोंधळ सम्बन्धी पौराणिक कथा

जमदग्नी ऋषी ने परशुराम को रेणुका देवी का सिर काटकर लेन को कहाँ। परशुराम आज्ञाकारी थे उन्होंने रेणुका देवी का शिरच्छेद किया परन्तु देवी का सिर उड़कर सत्यलोक में इंद्र के दरबार में जाकर गिरा। इंद्र ने इसे मंदिर में रखा और पूजाअर्चा की। जमदग्नी का क्रोध शान्त हुआ और परशुराम को उन्होंने रेणुका देवी का सिर लेन को कहाँ।

परशुराम ने 'गोंधळी 'का वेश धारन करके इंद्र के सभा में गया वहाँ उन्होंने गोंधळ प्रस्तुत किया। इंद्र ने प्रसन्न होकर उसे वर माँगने को कहाँ उस समय परशुराम ने रेणुका देवी का सिर माँगा। परन्तु इंद्र ने सिर देते समय एक शर्त रखी की , सिर ले जाते समय पीछे मुड़कर नहीं देखना। सिर ले जाते समय परशुराम ने पीछे मुड़कर देखा और रेणुका देवी का सिर उसी जग़ह रह गया और तब से रेणुका देवी के मुख की उपासना की जाती हैं। उपरोक्त कथा से रेणुकादेवी के उपासना में गोंधळ का महत्व दिखाई देता हैं।

गोंधळ की रूपरेषा

महाराष्ट्र के लोकप्रिय गोंधळ के दो प्रकार हैं।

- **१. काकडया गोंधळ** - काकड़े जलाकर जो गोंधळ प्रस्तुत किया जाता हैं , उसे काकड़या गोंधळ कहाँ जाता हैं। ये गोंधळ प्रातःकाल में गया जाता हैं।
- **२. संबळ गोंधळ** - संबळ (अवनद्ध वाद्य) , तुंतुने (तत वाद्य) इस वाद्य के साथ - संगत से गोंधळ प्रस्तुत किया जाता हैं। इसे संबळ गोंधळ कहाँ जाता हैं।

लेकिन इन दोनों प्रकारों से गोंधळ का स्वतन्त्र अस्तित्व आज कम होता दिखाई दे रहा हैं। आज गोंधळ दोनों प्रकारों को मिलाकर गाया जाता हैं। गोंधळ को पुर्व रंग और उत्तर रंग इन दो भागों में विभाजित किया जाता हैं। पुर्व रंग में पुजा रचि जाती हैं, देवी देवताओं के स्तुतीपर गीत , गण गाये जाते हैं और विविध देवताओं को गोंधळ में आने के लिए आवाहन किया जाता हैं। उत्तररंग में पौराणिक व्यक्ति - घटना - प्रसंग इनपर आधारित कथा गीतों का प्रस्तुतीकरण किया जाता हैं और अन्त में आरती की जाती हैं।

गोंधळ की पूजाविधि मुख्यताः श्याम समय के समय शुरू होकर रातभर चलती हैं। गोंधळ में घटस्थापना और देवी की साधना का अनन्य साधारण महत्व हैं। चौरंगपर नया कपड़ा डालकर चावल रखते हैं और उसपर हलदी -कुमकुम डालकर चावलपर सुपारी रखकर पुजा करते हैं , यह सुपारी विघ्नहर्ता गणेशजी का प्रतिक हैं। चौरंगपर हलदी -कुमकुम से नवग्रह निकालकर चौरंग के बिच में ताम्बे का कलश रखकर उसके मुखपर विडे के पाँच पानों को नारियल के साथ रखा जाता हैं। उसे घटस्थापना कहते हैं। इस पानपर कलश के सामने बादाम , खारक , केले , हलकुण्ड , सुपारी रखकर उसको हलदी - कुमकुम लगाकर पुजा करते हैं और दिया जलया जाता हैं।

इस पूजाविधि के बाद पुर्व रंग की शुरुवात होती हैं। लाल रंग का लम्बा कुरता , सरपर लाल पगड़ी , कमर को सफ़ेद दुपट्टा बंधा हुआ रहता हैं। गले में कौड़ी की माला इस पारम्परिक वेशभूषा तथा साथीदारों के पास संबळ , तुंतुने , झांज आदि पारम्परिक वाद्यों के साथ गोंधळ आरम्भ किया जाता हैं। प्रमुख गोंधळी सर्व प्रथम हाथ में जलती मशाल लेकर गाना शुरू करता हैं।

गण में गणेशजी के महात्म्य पर होते हैं। सम्पूर्ण कार्य निर्विघ्नता से पूर्ण होना चाहिए इसलिए गण गया जाता हैं। प्रमुख गोंधळी गण गाता हैं और साथीदार साथसंगत करते हैं। प्रमुख गोंधळी ' प्रथम गोंधळास कोण यावे ? ' ऐसा सवाल करता हैं। साथीदार कहता हैं की ,' मुळारंभ गजवदन गणपती गोंधळास यावे ' ऐसा जवाब देता हैं। मुख्य गोंधळी विविध देवी - देवताओं को गोंधळ में आने का आवाहन करते हैं जैसे –

तुळजापुरच्या भावनीमाते - गोंधळा यावे
माहुरची रेणुकामाता - गोंधळा यावे
अनुसया दत्तात्रेय - गोंधळा यावे
औंढा नागनाथा - गोंधळा यावे
परळीच्या बैजनाथा - गोंधळा यावे

इस प्रकार देवी देवताओं को गोंधळी गोंधल में आने का आवाहन करते हैं। देवी देवताओं को बुलाकर तुळजापूर की भवानी , माहुर की रेणुकामाता के महात्म्य पर और पराक्रम के गीत गाये जाते हैं जैसे -

अष्टभुजांची अंबाबाई

आईने वधिला दैत्यासुर ,शिरांचे केले पार

वर रचिले तुळजापूर। ...

उत्तरंग में कथा , नाट्य , नृत्य और संगीत इन विशेषताओं से रंगतदार होता हैं। इसमें गोंधळी पौराणिक कथा - गीत प्रस्तुत करते हैं। कथा में रेणुका माता जमदग्नि , परशुराम , हरिशचन्द्र - तारामती , श्रावणबाळ और श्रीरामचन्द्र ने देवी की प्रार्थना की और देवी ने श्रीराम को वर दिया इसप्रकार की पौराणिक कथा गोंधळी अपने कथा गीतों में बताता हैं। इसके उपरोक्त वीरसेन , चम्पुसेन , जयारानी इनकी कथाएँ गोंधळ में गायी जाती हैं और गोंधळ का अंत सुखात्मक होता हैं। गोंधळ की कथा , निवेदन शैली , नाट्य , सवाद इस दृष्टिकोण से कथागीत का प्रस्तुतीकरण का निम्नलिखित उदाहरण हैं -

ऐका माय - बाप हो , राजाच्या भक्तीची कथा

एक होती नगरी , सुखी होती प्रजा

नगरीच नाव चंपावती , कशाची नव्हती कमी

धन - धान्य, पैसा अड़का आन संपत्ती ...

उपरोक्त काव्य का अर्थ - एक नगरी में राजा राज्य करता था। वह सर्व गुण सम्पन्न और पराक्रमी पुरुष था। उसके गुणोंका वर्णन करते हैं। इस आशय की कथा कहते समय बिच - बिच में मुख्य कथा को पुरक उपकथा भी कहते हैं जैसे - समाज जीवन में उत्पन्न होनेवाली विनोदी प्रसंग की जोड़ देकर गोंधळ में रंगत लाने का प्रयास करते हैं। कथागीत सामस होने के पश्चात देवी की आरती की जाती हैं और गोंधळ सामस होता हैं।

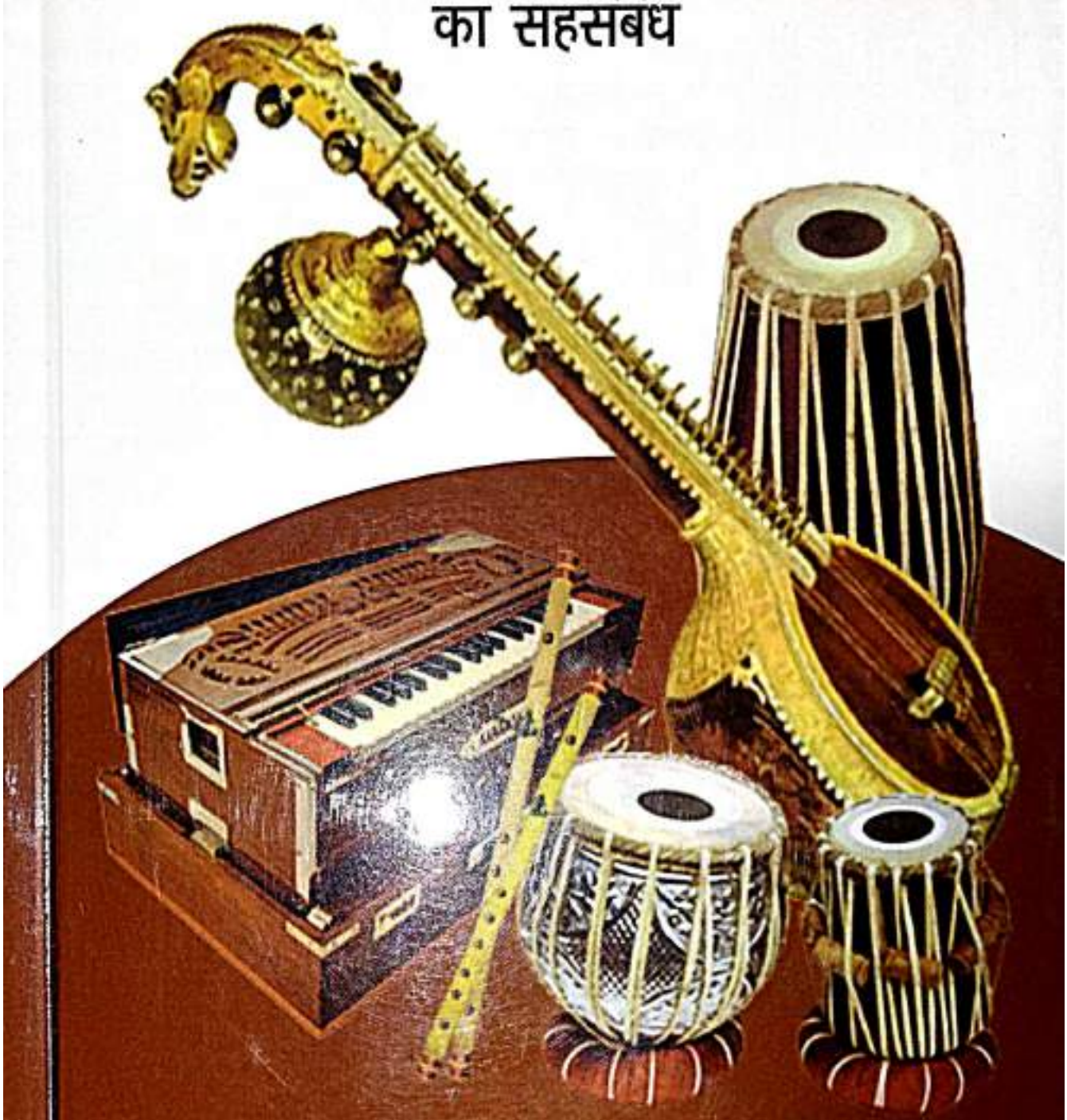
महाराष्ट्र के पारम्परिक गोंधळ में नृत्यनाटिका और संगीत इन तीनों तत्वो के सहयोग से प्रयोगात्मकता आइ हैं। कथानक की घटनाएँ और संगीत का ठेका इन बातों का सुमधुर संगम से गोंधळ की श्रवणीयता बढ़ती है. इनमें रंजनमूलय होते हैं। धार्मिक , आध्यात्मिक और सामाजिक उद्बोधन रंजनमूल्य के माध्यम से गोंधळ को लोकप्रियता मिली हैं।

सन्दर्भ ग्रन्थ

१. निबंध संगीत - लक्ष्मीनारायण गर्ग
२. लोकसंगीत अंक जाने १९९६ - हाथरस
३. महाराष्ट्रातील लोकगीते - विट्ठल कोळी
४. नृत्य एवं लोकसंगीत - अजय कुमार

Aesthetics in Various Types of Music & its Impact on Humanity

वर्तमान परिप्रेक्ष्य में संगीत और साहित्य का सहसंबंध



Editors

Mr. N.P. Singade • Mr. M.G. Wahane

Mr. S.P. Gajbhiye • Mr. N.G. Jadhav

Published by :
New Bhartiya Book Corporation
208, 2nd Floor, Prakashdeep Building,
4735/22, Ansari Road, Daryaganj,
New Delhi-110002
Phone : 011-23280214, 011-23280209
E-mail : deepak.nbbc@yahoo.in

First Edition : 2022

ISBN : 978-81-8315-501-4

Type Setting
Creative Graphics

Printed by :
Jain Amar Printing Press
New Delhi

Section-II : Marathi Paper

20

शास्त्रीय संगीत और लोकसंगीत का सहसंबंध

प्रा. वैशाली एस. चोरपगार

प्रस्तावना

प्रकृति सभी कलाओं का आधार है। जितनी भी कलाओं ने जन्म लिया उन सभी ने प्रकृति का ही अनुकरण किया है। पहले प्रकृति में चमत्कार पैदा होता है और उसका अनुकरण मानव अपनी सूजनशील चेतना से उसे प्रतिभा संपन्न करता है, जिसे हम कला कहते हैं। ऐसे ही अनेक कलाओं ने अनेक लोकसंस्कृतिक एवं लोक कला को जन्म दिया। लोगों ने लोगों के लिए बनाया हुआ लोगों का संगीत लोकसंगीत कहलाता है। इसी लोक संगीत से अनेक जनजातियों कला ने जन्म लिया आज भी भारत के सभी राज्यों में उस राज्य के अंतर्गत अनेक जनजातियों का लोकसंगीत कायम है। मानव जन्म से ही बुद्धिमान प्राणी है। उसके इसी बुद्धिवादी विचारधारा से कला का शास्त्र बना। इस शास्त्र में कई नियम-कायदे बनाए गए और एक अच्छा शास्त्र बनाया गया। आज भी सारी दुनिया में भारतीय शास्त्रीय संगीत अपना एक मकाम बनाकर रख दिया है। इस शास्त्र से कई राज रागिनियों, कई तालों और उसकी विविध लय ने जन्म लिया। शास्त्रीय संगीत से रससिद्धांत, दर्शन संगीत, सौंदर्यशास्त्र, मनोविज्ञान शास्त्र, संगीत थेरपी इ. कई विधापन का अविष्कार हुआ। वास्तविक रूप से शास्त्र का मूलाधार लोकसंगीत ही है।

लोकसंगीत आदिकाल से ही जनजीवन का अभिन्न अंग रहा है। लोकसंगीत प्रकृति की अनुठी देन है, आदिमानव ने शताब्दियों तक प्रकृति को अति निकटता से देखा है, प्रकृतिक सौन्दर्य ने आदिमानव के भीतर जिज्ञासा उत्पन्न को फलस्वरूप उसे रंजकता की अनुमति हुई और सौन्दर्यबोध की कल्पना आदि मानव के मन में उत्पन्न हुई। आदि मानव पशु-पक्षी, कीड़े-मकोड़े आदि के सवर से परिचित हुआ, अनुकरण की प्रवृत्ति जागृत हुई और अनेक स्वर से आपे स्वर को मिलाने का प्रयास

करने लगा। उनकी उड़ान, उनकी चाल तथा गति का अनुकरण करने लगा। पक्षियों की झूमती थिरकती हुई डालियों को देखकर स्वयं भी झूमने और थिरकने लगा। उसे झूमने, थिरकने आदि से लय और ताल की सुन्दर अनूमति हुई। नदियों और झरनो को कल-कल ध्वनि से उसके होठो में बोल, पैरो में थिरकन और शरीर में लचक प्रस्फुटित हुई, वह बुदबुदाने लगा। कुछ गाने लगा, बजाने लगा एवं विभिन्न और गतिशिल अंगो से संचालन करने लगा।

शास्त्रीय संगीत और लोकसंगीत एक वृक्ष की दो शाखाएँ हैं। संगीत के इन दोनों प्रकारो की विकसित दिशाएँ स्वतंत्र है तथा दोनों ही प्रौढ़ संगीत शैलियो के दो विकसित, स्वरूप है। शास्त्रीय संगीत के प्रेरणा स्त्रोत व्यक्ति एवं शास्त्र है और शास्त्र के नियमों में बँधा हुआ शास्त्रीय संगीत स्वतंत्रपूर्वक विचरने का अधिकार नहीं है।

लोकसंगीत का प्रेरणा स्त्रोत जन मानस है। उसका विकास और संचरण क्षेत्र अधिक विस्तृत है। शास्त्रीय संगीत के प्रयोग और प्रशिक्षण के लिए शास्त्रज्ञान की आवश्यकता है तथा विशिष्ट अभ्यास क्रम से गुजरने की जरूरत है। परंतु लोकसंगीत के प्रयोग के लिए किसी अभ्यास तथा ज्ञान की आवश्यकता नहीं है, शास्त्रीय संगीत वैयक्तिक साधना का प्रतीक है। संगीत रचनाएँ जब प्रौढ़ता को प्राप्त होती है, तभी उन पर शास्त्र बनते हैं। पहले रचनाएँ होती है, उनके अनेक वाद विवाद, उपप्रकार, क्रिया प्रक्रियाएँ चलती है, तब शास्त्रों का आधार लिया जाता है। अनिबद्ध रचनाओ को निबद्ध करने के लिए शास्त्र का निर्देश करता है। प्रारंभ मे शास्त्र सरल, सुगम तथा संक्षिप्त होता है। बाद में रचना क्रम के विस्तार के साथ वह भी पेचीदा होने लगता है। अनेक नियम, उपनियम, धारा, उपराधाओं की सृष्टि होती है।

लोकसंगीत ने निश्चित रूप से शास्त्रीय संगीत पर प्रभाव डाला है। उच्च वर्ग के लोग लोकसंगीत मे रूचि रखते थे क्योंकि वो परंपरा का हिस्सा बनना चाहते थे। कई प्रसिद्ध रचनाकारों ने अपने कुछ शास्त्रीय अंशो को पारंपारिक लोकसंगीत पर आधारित किया है। लोकसंगीत कई शास्त्रीय टुकड़ो में प्रभावशाली रहा है और संभवत: आने वाली शताब्दियों के लिए शास्त्रीय संगीतकारों को प्रेरित करना जारी रखेगा।

शास्त्रीय संगीत स्वरप्रधान होता है तो लोकसंगीत शब्दप्रधान होता है। लोक संगीत का स्वरूप सहज स्वच्छन्द एवं लयगर्भित होता है, शास्त्रीय संगीत जटिल एवं शास्त्रोक्त होता है, किन्तु सांगीतिक तत्वों के आधार पर दोनों में पारस्परिक सम्बन्ध

की अनुभूति विद्यमान है। लोकधुनों में शास्त्रोक्त रागे छुपी हुई है। शास्त्रीय पद्धति से गाए जाने वाले अनेक गीतों में लोक बोली के शब्द होते हैं, ऐसे ही शब्द लोकगीतों के आधार स्तम्भ होते हैं। लोकसंगीत में स्वर और ताल का सीधा महत्व नहीं होता है, किन्तु रचनाकार शास्त्रीय संगीत कर दृष्टि से रचना की युक्ति का निर्माण कर लेता है। तबला शास्त्रीय संगीत का प्रधान वाद्य है, किन्तु लोकसंगीततज्ञ इसका उपयोग पूर्ण मनोयोग से करते हैं जो शास्त्रीय संगीत और लोकसंगीत के पारस्परिक सम्बन्ध का परिचायक है।

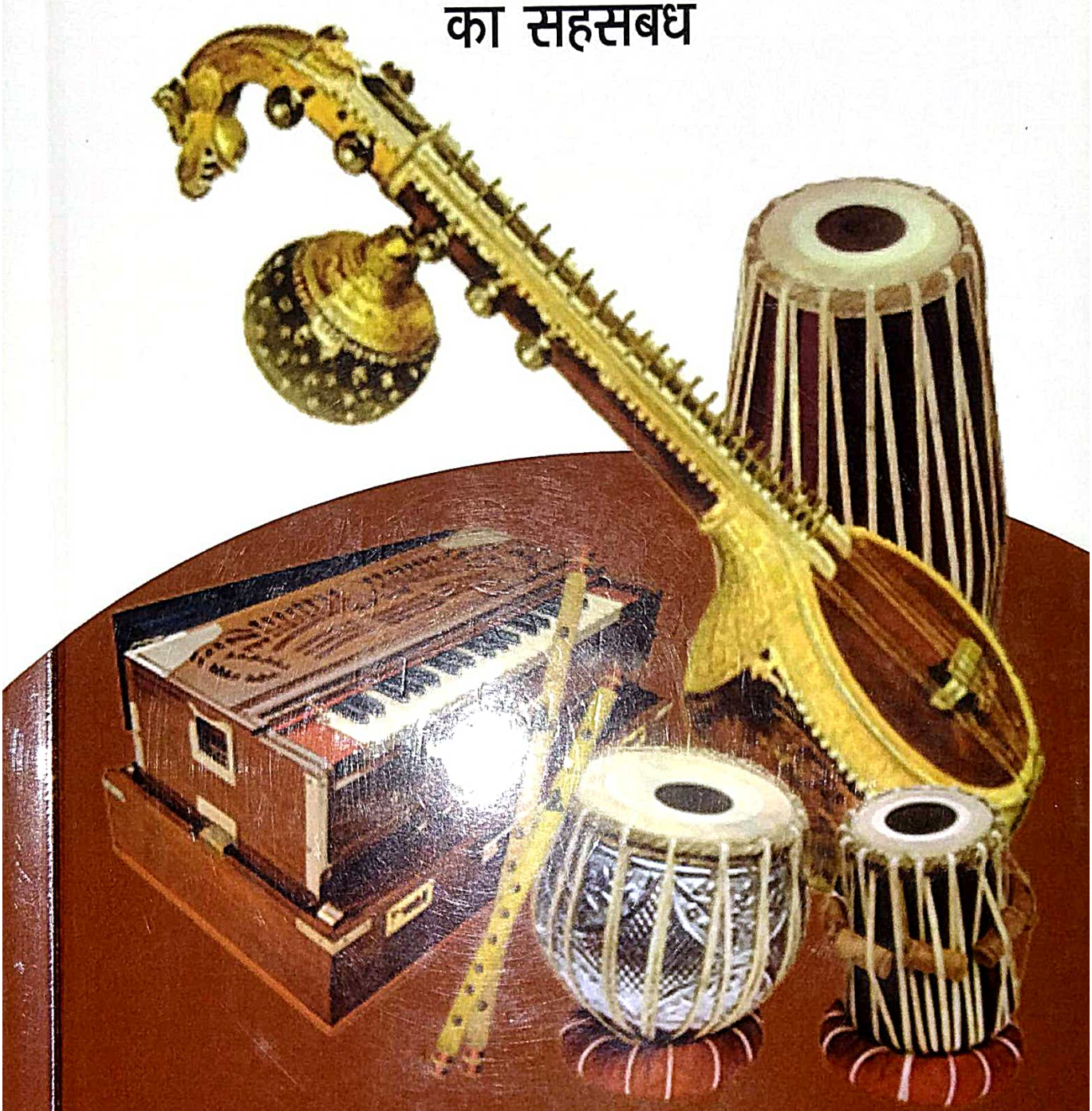
शास्त्रीय संगीत में कलात्मक है लोकसंगीत की कला मे सर्व ग्रहिता है।

संदर्भ संकेत

1. भारतीय संगीत (वैज्ञानिक विश्लेषण) - प्रो. स्वतंत्र शर्मा
2. राजस्थान के लोकसंगीत और उसमें प्रयुक्त लोक वाद्य - डॉ. अनिता
3. संगीत रत्नावली - अशोक कुमार
4. लोकसंगीत अंक - डॉ. लक्ष्मी नारायण गर्ग

Aesthetics in Various Types of Music & its Impact on Humanity

वर्तमान परिप्रेक्ष्य में संगीत और साहित्य का सहसंबंध



Editors

Mr. N.P. Singade • Mr. M.G. Wahane

Mr. S.P. Gajbhiye • Mr. N.G. Jadhav

Published by :
New Bhartiya Book Corporation
208, 2nd Floor, Prakashdeep Building,
4735/22, Ansari Road, Daryaganj,
New Delhi-110002
Phone : 011-23280214, 011-23280209
E-mail : deepak.nbbc@yahoo.in

First Edition : 2022

ISBN : 978-81-8315-501-4

Type Setting
Creative Graphics

Printed by :
Jain Amar Printing Press
New Delhi

विषय-सूची

Section-II : Marathi Paper

4

संगीत चिकित्सा

डॉ. नेत्रा तेल्हारकर

सारांश

किसी भी व्याधि से मुक्ती का उपाय चिकित्सा है। मानव जाती के मानसिक विकास के साथ हि उसका उदय हुआ। ब्रह्मांड विज्ञान के अनुसार ब्रह्मांड कि उत्पत्ती ध्वनि से हुई। ध्वनि अर्थात नांद, विशिष्ट आवाज जो की संगीत का प्राण है चिकित्सा विज्ञान चारों वेदों में विशेष रूप से प्राप्त होता है। इससे स्पष्ट होता है कि भारत में चिकित्सा विज्ञान का प्रथम प्रादुर्भाव हुआ और भारत के साथ हि अन्य देशों में इनका विस्तार हुआ। वैदिक काल से हि संगीत में रोग व निदान दोनों मिलते है। तब से ले को आज तक संगीत के क्षेत्र में संगीत चिकित्सा एक विशेष अभियान है जिस पर विशद कार्य अनुसंधान हो रहा है तथा इसका सफल परिणाम सामने आ रहा है। संगीत एक ऐसा पोषक तत्व है जो मन और आत्मा के लिए औषधी का कार्य करता है। संगीत की सुमधुर स्वर लहरिया मनुष्य के चित्त में एकात्रा व मानसिक सन्तुलन को बनाये रखने में सहाञ्चयक होती है। संगीत के प्रभावी होने में अनेक बातों का महत्व है जैसे स्वर, लय, ताल, बंदिश, रस, भाव, प्रकृती इ.। यह तक के रचनाओं के निर्माण में ऋतु काल, प्रहर तथा रागों के गायन, समय व समयानुकुल मनोदशा का भाव का भी ध्यान रखा जाता है। साथ हि लय - ताल का निर्धारण कर राग के संपूर्ण व्यक्तित्व को निखारने पर भी ध्यान दिया जाता है। इसलिये संगीत का स्वास्थ्य पर प्रभाव पडना व सकारात्मक प्रभाव, अनन्ददायक प्रभाव हि उपचार की दिशा व क्षेत्र को निर्धारीत करता है।

प्रस्तावना

कला हमें व्यापक तौर पर संपूर्ण जीवन का दर्शन कराती है उसी के साथ वह हमें ज्ञान आनंद स्वास्थ्य तथा शिक्षा प्रदान करके हमारे जीवन के सर्वांगीन विकास

में सहायक होती है। समस्त ललित कलाओं में संगीत कला को सर्वश्रेष्ठ माना जाता है क्योंकि सीमित साधनों में सूक्ष्म में सूक्ष्म भावनाओं की अभिव्यक्ति करने में संगीत कला सक्षम है। संगीत ध्वनि विज्ञान की एक शाखा है जिसमें विविध मनोदशाओं की घोंतक राग - रागीनीयां मनुष्य में रसानुभूती का संचार करती है, शारीरिक मानसिक व्याधियो से छुटकारा दिलाती है। संगीत से जो ध्वनि तरंगे उत्पन्न होती है वे स्नायु प्रवाहो पर प्रभाव डालकर न केवल उसकी सक्रियता को बढाती है वरना विकृत चिन्तन को रोक्ती है और मनोविकारों को मिटाती है। इसिलिए स्वर शक्ति के इस सृजनात्मक उपचार पद्धति पर आज वैज्ञानिकों तथा चिकित्सकों का ध्यान आकुष्ट हुआ है। इन ध्वनि तरंगोसे शरीर स्थित्व अंतस्त्रवी ग्रंथिया सक्रिय हो जाती है तथा हार्मोन्स को मानसिक स्थिति में परिवर्तीत करने के स्पष्ट संकेत मिलते हैं और उस परिवर्तीत मानसिक स्थिति को सुधारणे में यह विविध ध्वनि तरंगे काम करती है। प्राचीन काल से विविध ग्रंथों में संगीत के रोग निवारण क्षमता के वर्णन प्राप्त हुए है। जैसे नारदकृत संगीत मकरंद, शारंगदेव कृत संगीत रत्नाकर, मतंगकृत बृद्धदेशी, चरक संहिता मैद ऋषी के ग्रंथ शब्द -कौतुहल, अग्नी पुराण इ. वैदिक कालीन संगीत का विचार करे तो संगीत का प्रयोग लयात्मकता के आधार पर अज्ञात तथा ज्ञात शक्तियों को प्रसन्नकरने के लिए किया जाता था वही दुसरो और गेयता के कारण श्रुती परम्परा के निर्वाह में भी सहायक सिद्ध हुआ। इस तरह देखा जाए तो आधुनिक संगीत चिकित्सा की जडे हमारी वैदिक प्रणाली में विदयमान रही है। धर्म के साथ जोडकर इसका संबंध मानवी जीवन के साथ जुडा दिया ताकी उपचारीय शक्ति का लाभ सभी को मिले तथा जीवन निरोगपूर्ण व दीर्घायू बने। प्राचीन काल से हि मानव मानसिक ताजगी तथा शारीरिक स्फुर्ती के लिए गायन, वादन तथा नृत्य उत्सव करता रहा है। मनुष्य सुख में हो या दुख में आशा में हो या निराशा में इस तरह के अपने मनोभावों को संगीत द्वारा अभिव्यक्त करके वह मानसिक विकारों से बच सकता है। संगीत के इसी चमत्कारी शक्ति के करण संगीत का चिकित्सा के क्षेत्र में प्रयोग किया गया।

उदिष्ट

विश्व के महान दार्शनिक श्रेष्टो ने संगीत के महत्व को अनुभव करते हुए लिखा है की 'एक सफल शिक्षक को संगीतज्ञ होना आवश्यक है क्योंकि अन्य सभी विषयों से बढकर संगीत ऐसा माध्यम है जो न केवल मानसिकता को प्रशिक्षित कर्ता है वरन मनोभावों को भी प्रशिक्षित करके उन्हें विशुद्ध स्वरूप प्रदान कर्ता है,

जीससे व्यक्तिगत दुर्गुण दूर हो जाते हैं। वैज्ञानीकों का भी मानता है की मनुष्य की 80 प्रतिशत बिमारीयों का जन्म मानसिक आंधी व्याधी व चिन्ताओं से होता है और भारतीय राग स्त्र रागनिया पूर्णत: इस भाव से जुडी होकर हमारी भावनाओं से सम्बंध है जिसका मानव मन पर निश्चित प्रभाव पडता है। एक हि रोग के लिए अलग - अलग व्याक्तियों पर अलग - अलग रागों का प्रभाव हो सकता है। संगीत की उत्पत्ती एवं विकास का क्रमबद्ध अध्ययन करने से यह ज्ञात होता है की संगीत का उपयोग मनोरंजन के अतिरिक्त भी विभिन्न उद्देश्यों की प्राप्ति के लिए प्राचीन काल से किया जा रहा है। इन सभी को ध्यान में रखते हुए संगीत का उपयोग चिकित्सा हेतू किया जाय उस उदिष्ट से चाहे धर्म का क्षेत्र हो या विज्ञान का संगीत पर सबकी निगाहें है। यहाँ तक की संगीत को एक पृथक चिकित्सा पद्धति के रूप में देखा जाने लागा है। उसी चिकित्सा पद्धति का स्वरूप स्पष्ट करने का मानस सामने रखा गया है।

वर्णन

संगीत का उपयोग मानव ने मनोरंजन, वासना, ईश्वरीय उपासना इ. के अतिरिक्त चिकित्सकीय क्षेत्र में भी किया है। संगीत के चमत्कारीक शक्ति हेतू इसका प्रयोग चिकित्सा के उद्देश्य से किया जाना स्वाभाविक है। संगीत चिकित्सा का अर्थ होगा, संगीत की ध्वनि के प्रभावों से रोगोपचार करके व्यक्ति के। स्वस्थ राखना, प्रसन्न राखना। किसी चिकित्सा पद्धति में औषधीयों द्वारा जो कार्य शरीर में जैव रासायनिक परिवर्तन के माध्यम से होता है, संगीत चिकित्सा से वही कार्य स्वर लहरीयों द्वारा होता है। भारतीय संगीत में निहित नांद ऊर्जा मानव शरीर में संजीवनी शक्ति को जाग्रत एवं सक्रिय कर देती है। यही संगीत चिकित्सा का मूल तत्व है। संगीत चिकित्सा का संबंध आयुर्वेद से है। जिसमें व्यक्ति के प्रकृति के तीन भेद वात पित्त कफ बाताये है। इन्हीकी विकृतीयों से शारीरिक रोग होते हैं। और हमारे संगीतज्ञो तथा विद्वानोंने संगीत का संबंध सीधे शरीर स्थित इन श्रिेत्र वात, पित्त, कफ से बताया है। इसी के आधार पर संगीत में अर्थात शास्त्रेय संगीत में रागसमयचक्र की संकल्पना सामने आई। संगीत के जो विशिष्ट तत्व है जैसे स्वर, लय, ताल, बोल मानव शरीर से भी जुडे हुए है। संगीत में स्वर का अत्यंत महत्व है जो प्राकृतिक रूप से मनुष्य में विदयमान है। 'लय' जो मनुष्य में श्वास गति नाडी गति के रूप में विघमान है। बोल जो है मनुष्य के वाणी से व्यक्त होते हैं।

संगीत चिकित्सा के अंतर्गत सहाञ्चयक तत्वों में राग के विशिष्ट तत्वों की भूमिका महत्वपूर्ण है। स्वर, लय, ताल, पद (बंदिश) रस स्त्र भाव इ. राग के

महत्वपूर्ण घटक अपनी भुमिका स्पष्ट करते हैं। राग संगीत का मुख्य स्त्रेत स्वर है। कुल स्वर सात है। इनमें से पांच स्वर विकृत है जो कोमल और तिव्र होते हैं। ऐसे कुल स्वर ङ्ह होते हैं। और इन्ही स्वरों के शुद्ध कोमल अवस्था के आधार पर असंख्य रागोंक निर्माण हुआ है। यदी रोगों के निवारण में रागों की भूमिका पर ध्यान दे तो चिकित्सा में प्रयुक्त होणे वाले रागों की प्रभावाशीलता व उपचारीय क्षमता के पिछे निहित है, उस राग की व्यक्तिगत विशेषता याने प्रयुक्त होणे वाले स्वर, उनका न्यास, अल्पत्व - बहुत्व, वादी - संवादी, संवाद तत्व, रस-भाव प्रकृति इ.। इन सब बातों के पिछे गंधर्वजि का याही मानना था की किसी भी राग को गाने के लिए उस राग के भाव को स्वरों को समझना व महसूस करना आवश्यक है ताकी हम पुरी तरह राग को जाने तभी वह राग भी प्रभावी होगा। कोमल ग, ध, नी स्वर राग मालकंस और दरबारी कानडा रागों को धीर गंभीर बनते है। और इस राग के आलापचारी से अनिद्रा के रोगी को लाभ पाते हैं। अति दु:ख से दुखी व्यक्ति को राहत देणे में तथा न रो पाने की स्थिति में रुलाने के लिए तथा मन हल्का करने के लिये राग जोगिया, जौनपुरी, मालकंस रागों की सहायक होती है। शारीरिक थकावट तथा उत्साह वर्धक स्थिति निर्माण करने में राग काफी के कोमल गांधार और निषाद स्वर महत्वपूर्ण, भूमिका निभाते है। जैसे। जैसे टहनिक हो। तिव्र मध्यम स्वर प्रधान रागों में जैसे कल्याण थाट जन्य रागों का मुख्य गुण है मानसिक तनाव व निराशा आदी से मुक्ती दिलाना। राग केदार मन शांती प्रधान करने मे, विशेषत : डिप्रेशन की स्थिति में मुक्ती दिलाने में सक्षम है। राग भैरव के रे ध कोमल स्वर व्यक्ति के चित्त को एकाग्र काराने तथा एकाग्रता बढाने मे, मन को ईश्वर के साथ जोडने में साहाञ्चयक होते हैं। शांत रस की पृष्टी कर्ता है। इस तरह से विभिन्न रागों के सहाञ्चयतासे रोगी के रोग को जानकर इलाज कराया जाता है।

संगीत चिकित्सा के बारे में सोचे तो यह पद्धति अन्य चिकित्सा पद्धति से अलग है। संगीत चिकित्सा पद्धति को समझने के लिए ध्वनि विज्ञान, सौंदर्यशास्त्र, मनोविज्ञान, शरीर रचना, शास्त्र, समाजशास्त्र इ. जैसे विषयोंका बोध होना जरून है। तथा चिकित्सक को भी कुछ महत्वपूर्ण बातों को जानना जो रोग और रोगी संबंधित है अत्यंत आवश्यक है। जैसे पारिवारिक पृष्ठभूमि को जानना, परिवार के सादस्यों का रोगी के प्रती व्यवहार, मनोचिकित्सक की सृष्टि से रोगी के मन मस्तिष्क में कैसे विचार चल रहे है। रोगी के भावनायों को समझने की कोशिश करना। जरुरत पडणे पर शरीर परीक्षण भी कराना यह सब बाते समझना अत्यंत जरुरी है।

संगीत उपचार पद्धति में सर्वप्रथम रोगी को स्वस्थ करने के लिए उसकी मानसिक स्थिति को समझना आवश्यक है। इसका स्वभाव, बर्ताव जानना जरुरी होता है। रोगी अपने प्रकृति के अनुरूप हि संगीत सुनता है एवं प्रभावित होता है। प्रत्येक व्यक्ति की अपनी अलग रुची होती है। चिकित्सा करेने से पूर्व उसकी पसंदीदा संगीत जैसे शांत उत्तेजक संगीत को ध्यान में रखकर संगीत चिकित्सक को भावयुक्त संगीत सुनाना चाहिये जीससे वो मनोवंचित लाभ प्राप्त कर सके। अपने अपने भावात्मक और चिंतनात्मक विकास के अनुसार प्रत्येक को कोई विशेष संगीत हि अच्छा लागता है। संगीत श्रवण के दौरान रोगी के हावभाव, शारीरिक प्रतिक्रिया यदी से उनके रोग की तीव्रता व गंभीरता को मापा जा सकता है और उस दौरान उसे आनंदी, शांत और पसंदीदा संगीत जादा से जादा सुनने के लिए प्रेरित करना जरुरी होता है। संगीत चिकित्सा फलप्रद होने के लिए रोगी को भी दिशा - निर्देश दिये जाते हैं। जैसे

1. ध्वन्यांकीत संगीत को हेडफोन से सुनना चाहिए।
2. एकाग्रचित्त व तनाव रहित सुने।
3. अपनी रुची का संगीत सुने अथवा चिकित्सक की सलाह है।
4. चिकित्सा पद्धति पर आस्था रखे।

उस तरह रोगी के साथ उसकी मनोदशा के साथ संगीत का संबंध बड़ा धनिष्ट होता है। स्वास्थ्य पर संगीत के प्रभाव को लेकर भारत तथा अनेक देशों में हुए अध्ययनों के आधार पर निष्कर्ष सामने आये है।

एकाग्रता, ध्यान केन्द्रित करने की क्षमता व सृजनात्मकता बढ़ती है। सकारात्मक उर्जा का स्तर बढता है। रोग प्रतीरोधक क्षमता को बढाता है। बेचौनी, निराशा, तणाव कम हो जाता है।

निष्कर्ष

संगीत का प्रभाव मानवी शरीर के अलावा मनुष्य की मानसिक स्थिति पर बहुत जल्द व अधिक होता है। संपूर्ण बातो उदाहरणों अनुभवो के बाद यह बात सामने आती है की रोग से ग्रासित व्यक्ति तथा राग अर्थात मधुर संगीत के बिच एक अमूर्त संबध होता है जो प्रभाव के रूप में शारीरिक या मानसिक मुर्त दिखाई देता है। संगीत चिकित्सा का स्थूल रूप से वैज्ञानिक कारण ढुंढना तो जरुरी है ही परंतु संगीत एक युनिव्हर्सल भाषा है और मानवजीवन का उल्हास है। इस प्रकार से यह

मेन्टल हाईजीन व रेमेडी है तथा स्वयं में सकारात्मक ड्रर्जा है जिसका प्रभाव समस्त प्राणी जगत स्वीकारता है। अंत में यही कह सकते हैं कि संगीत चिकित्सा के माध्यम से मानव को स्वस्थ, व्याधी मुक्त रखने की कल्याणकारी भावना भारतीय संगीत में वेदों से आज तक सतत प्रावाहीन है संगीत स्वयं में हि एक थेरपी है। इसे सामाजिक उपयोगिता के संदर्भ में देखते हुए चिकित्सा के माध्यम से मानव को स्वस्थ, निरोगी एवं दीर्घायु जीवन प्रदान करना हि इस पद्धति का उष्ठेश्य है। संगीत चिकित्सा का क्षेत्र अत्यंत व्यापक है। भविष्य में इस क्षेत्र में विपुल संभावना है। आवश्यकता है इस पद्धति की उपचारात्मक क्षमता को जानने - समझने की।

ग्रंथ सूची

1. भारतीय संगीत द्वारा चिकित्सा - डॉ. सोनिका पारिक
2. राज, रोग व रोगी (संगीत चिकित्सा) -डॉ. ज्योती सिनहा
3. संगीत विशारद - वसंत्व

13

संगीत और मानसशास्त्र का बाल व किशोर अवस्था में मानसिक फायदे

डॉ. वृषाली देशमुख

सारांश

ध्वनि (साऊंड) एक निश्चित भौतिक प्रक्रिया है, और जीस प्रकार प्रकृती और प्राणी जगत में प्रकाश और गर्मी का प्रभाव होता है। इससे उनके शरीर बढते, और स्वस्थ होते हैं। उसी प्रकार ध्वनि में भी तापीय और प्रकाशीय उर्जा होती है। और वह प्राणीयों के विकास में इतना महत्वपूर्ण स्थान रखती है। जीतना अन्न और जल पिढीत व्यक्ती के लिए तो संगीत उस रामबान औषधी की तरह है, जीसका श्रवणपान करते ही तात्कालीक शांती मिलती है।

लोग कहेंगे यह भाऊक अभिव्यक्ति मात्र है, किंतु वैज्ञानिको और शोधकर्ताओं ने संगीत की उन विलक्षण बातों का पता लगाया है, जो मनुष्य शरीरमें शाश्वत चेतना को और भी स्वप्रमाणित करती है।

उद्देश्य

गाना- नाचना, गीत-संगीत निश्चित रूप से प्रसन्नता की वृद्धी करते हैं। यह शरीर की स्थुल प्रक्रिया है। संगीत को हृदय और भावना में उतार लेने से तो मनुष्य का आत्मीय काया-कल्प ही हो सकता है। संगीत एक प्रकार की स्वरसाधना और प्रानायाम है। जिससे शरीर के भितरी आवयवों का व्यायाम भी होता है। और ऑक्सीजन की वृद्धी भी फलस्वरूप पाचनशक्ति, गहरी निंद, चौडी छाती और हीयों की मजबुती का स्थुल लाभ तो मिलता ही है। दया, प्रेम, करूणता, उदारता, क्षमा, आत्मीयता, सेवा और सौजन्यता के भाओं का तेजी से विकास होता है। यह सदृढ अपनी प्रसन्नता और आनंद का कारण आप है। वैसे एसे व्यक्ति के लिये सांसारीक प्रेम और संयोग का भी अभाव नहीं रहता।

संगीत और मानसशास्त्र का बाल और किशोर अवस्था में क्या क्या फायदे है। संगीत में उपचार करने कि, शक्तियां होती है, और एक गर्भवती मॉ को गर्भ के दौरान अपनी गर्भस्थ शिशू को लाभ पहुंचाने के लिये गर्भावस्था के दौरान सुखदायक संगीत सुनने की सलाह दी जाती है। संगीत आपको आराम करने में मदत करेंगा और यह अपने आप में बच्चे की वृद्धी और कल्यान के लिये अच्छा है।

प्रस्तावना

देखा गया है कि, शरीर में प्रात:काल और सायंकाल ही अधिक शिथीलता रहती है। उसका कारण प्रोटोप्लाज्मा की शक्ति का ऱ्हास है। यो प्रात:काल शरीर थकावट रहित होता है। पर पिछले दीन की थकावट का प्रभाव आलस्य के रूप में उभरा हुआ रहता है। प्रोटोप्लज्मा जिससे जीवीत शरीर की रचना होती है। इन दोना समयो में अस्त-व्यस्त हो जाता है। उस समय यदी भारी काम करें तो शिथीलता के कारण शरीर पर भारी दबाव पड़ता है। और मानसिक खीस और उद्विग्नता बढ़ती है।

संगीत में यह प्रतिक्रीया सबसे तीव्र होती है। संगीत में सर्वप्रथम कला का प्रस्तुतकर्ता अर्थात सर्वंग एवं संवेदनाओं का प्रथम उपभोक्ता ही इसके सम्मोहन में आता है। संगीत पर अनुसंधान व अभ्यास करने वाला व्यक्ति स्वयं भी एक सम्मोहन के मनोविज्ञान के प्रभाव में अपनी समस्त भावनाओं को संगीत से जोड़ता अथवा संगीत को समर्पित करता है। संगीत, मानव के सर्वाधिक निकट है। यह उसके प्रथम मनुष्य के जन्म से ही जुडा है। प्राचीन काल से ही मनुष्य द्वारा स्वयं की देह संरचना को संगीत से जोडने का भाव सामने आता रहता है। गवेद के ऐतरेय आरण्यक में प्रस्तुत दैवीक तथा मानुषी विना का सुंदर सामंजस्य इसी पक्ष को रंगीत करता है।

शिक्षा- मनोविज्ञान का महत्व

मनोविज्ञान के शिक्षा में प्रवेश करने से अनेक क्रांतीकारी परिवर्तन आये है। परिणाम स्वरूप शिक्षा आदान प्रदान की प्रक्रिया ही परिवर्तीत हो गयी है। आज कोई भी अध्यापक शिक्षा-मनोविज्ञान की अपेक्षा करके आपने शिक्षण को न तो सफल बना सकता है, और नहीं छात्रों का बहुमुखी विकास कर सकता है। मनोविज्ञान या शिक्षा - मनोविज्ञान ही अध्यापक को बताता है कि, सीखने की सर्व श्रेष्ठ विधी कौन-सी है। बालक का चरित्रिक और मानसिक विकास किस प्रकार हो सकता है, तथा बालक को किसी अवस्था में किस प्रकार की शिक्षा मिलनी चाहिए। मनोविज्ञान के सिद्धांत तथा व्यवहार का ज्ञान शिक्षक के लिये अत्यंत उपयोगी है। इस प्रकार

के ज्ञान से वह शिक्षक अपने शिक्षक को मर्यादा मात्रा में सुधार सकता है। तथा अपने शिक्षक को प्रभावपूर्ण बना सकता है। यह कार्य एक शिक्षक किस प्रकार कर सकता है। किसी भी अध्यापक के लिए मनोविज्ञान के अध्ययन की आवश्यकता क्यों होती है। इसी संबंध में भिन्न-भिन्न मनोवैज्ञानिको और शिक्षा शास्त्रियों ने अनेक विचार व्यक्त किये हैं। इनमें से एक विचार यह है कि,

बालको के लिये मनोरंजन की व्यवस्था

कार्य की अवधि में यदी स्वस्थ मनोरंजन की व्यवस्था हो तो थकान का अनुभव कम होता है। शिक्षक को चाहिये की बीच-बीच में बालकों को ज्ञानवर्धक बातें, चुटकुले, कहानियाँ, गीत आदी सुनाकर एवं सुनकर उनका मनोरंजन करता रहें। विद्यालय में इनका स्थायी प्रबंध भी होना चाहिये।

कक्षा में बालकों को थकान से बचाने के उपाय में उनका इस प्रकार मनोरंजन करना चाहिये कार्य की अवधी में थकान से बचने का एक अच्छा उपाय मनोरंजन है। विद्यालय में बालकों के स्वस्थ मनोरंजन के हेतू उनकी रूचियों के अनुकूल अनेक प्रकार के मनोरंजन की व्यवस्था होनी चाहिये। विभिन्न प्रकार के खेल, साहित्य, रेडीयो, टेलीविजन और कभी-कभी चलचित्र आदी बालकों का अच्छा मनोरंजन करता है। शिक्षक भी अपने विद्यार्थीयों को छोटी छोटी शिक्षा प्रद, कहानीयाँ, चुटकुले और गीत आदी सुनाकर बीच-बीच में यदी बालकों का मनोरंजन कराते रहें तो बालक थकान का अनुभव कम करेंगे।

मानव के जन्म के साथ ही शरीर एक नए वातावरन, बदलाव और स्पर्श के सम्पर्क में आता है। नवजात शिशू का मनोविज्ञान इसकी प्रतिक्रया कर देता है। यहा पीडा व वातावरन में हुए परिवर्तन को पहचाननेकी क्षमता और उसके विरूद्ध उत्पन्न प्रतिक्रया, सिधे-सिधे मस्तिष्क से जुडती है। अर्थात उसका यह सहज प्रतिक्रयात्मक मनोविज्ञान, जन्म के समय उपस्थित है। तथा रोने की क्रिया अथवा व्यवहार उस नवजात का अनुभव व भाव है।

यहाँ यह स्पष्ट होता है कि, मनुष्य के जन्म के साथ ही उसक भाव, उसकी भावना और उसकी अभिव्यक्ति भी जन्म ले लेती है। किसी भी मनुष्य को अपने जन्म की तिथी या समय भले ही ना पता हो, किंतू उसे बालावस्था की कुछ धुंधली सी मधुर स्मृतियां अवश्य स्मरण रहते हैं। बालावस्था में ही संगीत की पृभूमी से संचीत लोरी, गीत, पुजा, यज्ञ, इबादत या अन्य कोई भी लयात्मक ध्वनि उसके विकास के साथ उससे जुडती चली जाती है, और इसी कारनवश वह अंजाने में ही

संगीत और साधना से जुडता चला जाता है। यहाँ संगीत द्वारा भावनात्मक संबंध और विचारों के साथ साथ उसके व्यक्तित्व के निर्माण का शुभारंभ भी हो जाता है। जो आगे चलकर उसे अन्य लोगों से अलक भी करता है। मनुष्य के दबे हुए विशुद्ध भावों एवं उसकी अपूर्ण इच्छाओं की सर्वश्रेष्ठ अभिव्यक्ति भी (अश्रु) ही है। इसीलिये किसी भी मानव में रोने अथवा भावुक होने की प्रतिक्रीया को विशुद्ध व सहज माना जाता है। संगीत द्वारा जबभी मनुष्य के इस भाव कों उद्वेलीत किया जाता है तो एक विकसित और अनुभवी व्यक्ति भी कीस नवजात की तरह जीवन में पीछे छुट चुके अपने सुखो-दुखो और अनुभवों तथा स्मृतियों की प्रतिक्रया में रो देता है। यहाँ संगीत, पीछे छुटचुकी भौतिक पिडाओं कों मानवीय वेदनामें बदल कर भाव को संतुष्टी व प्रकटीकरण का पथ प्रदान करता है। यह तथ्य और सरल करने के लिए हम कुछ रागों और स्वरों का संक्षीप्त विश्लेषण भी कर सकत है। जो मनुष्य में मार्मीक संवेदनाओं को जन्म देकर उसे उसके मनस में उपस्थित निराशा और निरसता के व्यर्थ भावों से मुक्त करत देते है। जैसे राग बागेश्री यह मध्य रात्री में गाया जाने वाला राग है। यहा मध्यरात्री सें एकांत, एकाकीपन और सन्नाटे का बोध होता है। यहँ संवेदनाओं और स्मृतियोंके पूर्णजन्म का विशुद्ध प्रहर है। राग के कोमल गन्धार व कोमल निशाद स्वर स्मृति और अन्य मार्मीक भावोंको जन्म देने में सहायक होते हैं। इस रागका प्रस्तुतकर्ता और श्रोता दोनों ही एक भावुक मनोविज्ञान से सत्संग करते हैं। इसकी अधिकांक्ष बंदीशो में विरह और पिढा की मनोभाव देखे जा सकते है।

संगीत के मानशास्त्र में भावना को अत्यंत महत्वपूर्ण माना जाता है। संगीत के माध्यम से कलाकार विविध भाव निर्माण करता है। विविध भावना के निर्मीती से जीवन में रस निर्माण होता है।

शिशूओं की वृद्धी और विकास करने के लिए अमेरीका का फ्लोरीडा राज्य शिग्र ही उनकी माताओं को शास्त्री संगीत के कैसेट और सीडी जारी करेंगा।

शिशू व संगीत से संबंधित खोज में जो जीया के गव्हर्नर जैल मिलर ने अभी हाल ही में एक रेडीओ इंटरव्यु में बताया कि, अनेक अध्ययानो से यह सिद्ध हो चुका है कि, शास्त्रीय संगीत शिशूओंको अधिक बुद्धिमान बनाता है। यदी बच्चा संगीत सुनाता है तो, उसके मस्तिष्क की कोशिकाये जल्दी-जल्दी विकसित होती है।

आधुनिक चिकित्सा के विद्वानबी संगीत के महत्व को नहीं नकारते। आधुनिक चिकित्सा में प्रसिद्ध दार्शनिक रजनिश की संगीत थेरेपी को भी अत्यधिक प्रसिद्ध

व सफलता मिली है। इसके द्वारा कई लोगों को लाभ भी प्राप्त हुआ है। आर्युवेदमें शरीर की 22 नाडीओं को प्रमुखता से जाचॅ के क्षेत्र में रखा जाता है। इधर संगीत में भी 22 श्रृतीयों की मान्यता है। यहाँ फीरसे स्वर व नाडी गती में तिव्रता, क्रिया, कंपन व जीवन की उपलब्धता कों समझाने का प्रयास है। वर्तमान में संगीत के द्वारा शरीर वनस्पती जीव जगत पर कीये जा रहे है। कुछ अन्य चिकित्सा के प्रयोग व निष्कर्ष इस प्रकार है।

शिशूओं के मस्तिष्क और संगीत के सुरो में बीच किसी ना किसी प्रकार का रिस्ता जरूर है। कॅलिफोर्नीया विश्वविद्यालय के नाडी विज्ञान के विशेषज्ञ डॉ० गोदान शॉ ने अपने प्रयोग के क्रम में 3 से 5 वर्ष के बच्चों को नियमित रूपसे शास्त्रीय संगीत का अभ्याय कराया था। इस प्रयोग के बाद उन्होंने पाया कि, साधारण बच्चों की तुलना में इनमें स्पैटीयल टेम्पोरल रिजनींग में बढोतरी हो गयी थी। इसकी जरूरत इंजीनिअरींग, गणीत तथा, शतरंज जैसे खेलो में होती है। इस तरह का प्रयोग कॅलीफोर्निया के दुसरी स्कुलो में भी करके देखा गया है। जहाँ सप्ताह में बच्चों को दो बार पियानो पर शास्त्रीय रागों को सिखाया गया। बाद में पता चला कि, जीन बच्चो में गणीत संबंधी कुछ कमजोरिया थी उनमें सुधार की संभावनाएॅ नजर आने लगी थी। हाल की निर्णायक रूप से अभी सभी विषेशज्ञो में मतैक्य नहीं है। लेकिन इस तथ्य से सभी सहमत नजर आते है, की बच्चों के मस्तिष्क का शास्त्रीय संगीत के साथ एक रहस्यात्मक संबंध जरुर है।

संगीत के विषय में डॉ० बर्नर ने लिखा है, गाणेकी क्रिया से शरीर में उथल पुथल होती है। जिससे रक्तसंचार में वृद्धी होती है। संगीत का प्रभाव हृदय तथा मस्तिष्क पर इलेक्ट्रो-कार्डीयोग्राम - इलेस्ट्रो - इन्सलोग्राम द्वारा विद्युत तरंगो पर देखा जा सकता है। वे राग जीनके गायन एवं वादन द्वारा रोगो पर अनुकल प्रभाव देखा गया है। पागलपन का रोग, राग बहार व बागेश्री से दुर किया जा सकता है। मिर्गीकी बिमारीमें राग बिहाग व धाती सें लाभ मिलता है। सिरदर्द की तकलीफ को राग सोहनी, तोडी एवं भैरवी से दुर किया जा सकता है। रक्तभार का इलाज राग पूर्वी, तोडी एवं भूपाल तोडी द्वारा संभव है। संगीत से स्मरण शक्ति बढ़ती है। उसी प्रकार भावना व्यक्त करने कि, क्षमता बढ़ती है। संगीत के कालबद्ध ऐसे विविध अलंकारों के रियाज से बौद्धिक सतर्कता बढ़ती है। जिस विद्यार्थी को प्रस्थापीत शिक्षण पद्धति में अपयश मिलता है। और तनावग्रस्त होते हैं, वो मानसशास्त्रज्ञ के मत से और विद्यार्थी अगर संगीत पढता हो तो वो संगीत माध्यमसे शैक्षणिक यश में वो सुधरता है।

निष्कर्ष

संगीत एक पवित्र अनुभूती और अभिव्यक्ति है। संगीत का साधक अपनी देह के यंत्रसे सर्वप्रथम स्वयं ही संगीत (लय) के गुणो व कणो को सुनता व संग्रहीत करता है। संगीत एक साधक की आत्मीक और अध्यत्मिक धरोहर है। स्वयं के इस अनुभव व आचरण को श्रोता से बाटने का सौभाग्य उसकी आराधना का सबसे महत्वपूर्ण पडाव है। इस संबंध और सत्संग के लिये साधक (संगीतज्ञ) व श्रोता कों अनुशासन, आचरण, सहनशिलता व संगीत के नियमों में व्याकरण का उचित पालन करना चाहिये। अन्यथा यह पवित्र व अत्यंत वैज्ञानिक कला मनस को साधने की जगह मनोरंजनका साधन बन कर रह जायेंगी।

केवल अर्थ, ख्याति, प्रशंसा, प्रणव व प्रतियोगिता ही किसी सदृढ संगीतज्ञ के लक्षण नहीं है। उसे इनसे बचना चाहिये। संगीत की अनुभूती ही संगीत का सार्थक आनंद है। एक श्रोता को संगीत का यह धर्म जानकर ही संगीत सभा में संगत करनी चाहीए। मनोविज्ञान के प्रभावसे संगीत में तथा संगीत के प्रभावसे मानव व्यवहार में परिवर्तन आऐ है। यह एक ऐसी प्रक्रिया है, जो जीवन पर्यंत चलती रहती है। अतः समस्त विषय का विश्लेषन अर्थात मर्म यही है। की मानव के मनस (मस्तिष्क) उसके मनोविज्ञान (व्यवहार) व उवके सबसे निकट व निजी संगीत की प्रकृती व उत्पत्ती का धरातर व सार एक समान है। यह दोनों ही वास्तविकताऐं इस संपूर्ण मानव जगत के विकास व परिवर्तन की कुंजी है।

संदर्भ

1. संगीतशास्त्री, विज्ञान भाग -2 लेखक डॉ० सुचेता बिडकर, संस्कार प्रकाशन पृष्ठ क्र. 278 पुणे
2. शिक्षा मनोविज्ञान के मुलतत्व - मधुलिका शर्मा, संपादक प्रो. आर.पी. पाठक, डॉ० अस्मिता पांडेय भारद्वाज कनिष्क पब्लीशर्स, डिस्ट्रिब्युटर्स नई दिल्ली प्रथम संस्करण पृ क्र. 19, 133
3. संगीत, कला आणि शिक्षण - लेखक पंडीत सुधीर माईनकर, संस्कार प्रकाश पी. एन. 133
4- http://literature.anoe.org 7 April
5. संगीत एवं मनो विज्ञान लेखक - डॉ० किरन तिवारी कनिष्क पब्लीशर्स, डिस्ट्रिब्युटर्स नई दिल्ली

आजादी का अमृत महोत्सव

Vidarbha Youth Welfare Society, Amravati's

INDIRABAI MEGHE MAHILA MAHAVIDYALAYA, AMRAVATI

Irwin Square, Morshi Road, Amravati

One Day Interdisciplinary National Conference

This is to certify that

Mr./Mrs./Prof./Dr. Jyotsna Pusate

of J. D. Patil Sangludkar Mahavidyalaya, Daryapur

has Participated in One Day Interdisciplinary National Conference on " Women's Contribution to Modern Indian Society " held on 7th of November, 2022.

He/She Chaired a session on _____

Presented Paper entitled Indian Constitution & Women

Choudhary

Dr. Punam Y. Choudhary
Convener

Dr. Leena S. Kandalkar
Principal

Impact Factor-8575 (SJIF)

ISSUE No -
(CCCLXXIII) 373-A

ISSN-2278-9308

November-2022

B.Aadhar

Peer-Reviewed & Refreed Indexed

Multidisciplinary International Research Journal

Vidharbha Youth Welfare Society, Amravati's

INDIRABAI MEGHE MAHILA MAHAVIDYALAYA, AMRAVATI

AND

AADHAR SOCIAL RESEARCH, DEVELOPMENT AND TRAINING INSTITUTE, AMRAVATI

ORGANIZE

ONE DAY INTERDISCIPLINARY NATIONAL CONFERENCE

ON

WOMEN'S CONTRIBUTION TO MODERN INDIAN SOCIETY

Date : 7th of November, 2022

Chief Editor
Prof. Virag S. Gawande
Director
Aadhar Social
Research & Development
Training Institute Amravati

Executive Editor
Dr.Leena Kandlkar
Principal
Indirabai Meghe
Mahila Mahavidyalaya.
Amravati. Maharashtra

Editor
Prof. Dr. Punam Choudhary
Convener
Indirabai Meghe
Mahila Mahavidyalaya.
Amravati. Maharashtra

For Details Visit To : www.aadharsocial.com

Aadhar Publications

INDEX

Indian Constitution & Women

Dr. Jyotsna Pusate
Head of Home-Economics Department J.D. Patil SangludkarMahavidyala,Daryapur.
Mob.No.8975483595

The rights available to woman (ladies) in India can be classified into two categories, namely as constitutional rights and legal rights. The constitutional rights are those which are provided in the various provisions of the constitution. The legal rights, on the other hand, are those which are provided in the various laws (acts) of the Parliament and the State Legislatures.
The main privileges granted to women by Constitution of India are as follows:

Preamble of the Constitution:-

Under the Constitutional law, women have equal rights as men so as to enable them to take part effectively in the administrative of the country.

Equality before law:-

Article 14 embodies the general principles of equality before law and equal protection of laws.

Prohibition from discrimination on grounds of religion, race, caste, sex or place of birth:-

Article 15(1) and (2)prohibits the state from discriminating against any citizen only on the basis of any one or more of the aspects such as religion, race, caste, sex, place of birth or any of them.
Article 15(3) makes it possible for the state to create special provisions for protecting the interests of women and children.
Article 15(4) capacitates the State to create special arrangements for promoting interests and welfare of socially and educationally backward classes of society.

Equality of Opportunity:-

Article 16 provides for equality of opportunity for all citizens in matters relating to employment or appointment to any office under the State.

Article 39 requires the State to direct its policy towards securing for men and women equally the right to an adequate means of livelihood [Article 39(a)]:, and equal pay for equal work for both men and women [Article 39(d)].

Article 39A directs the State to promote justice, on the basis of equal opportunity and to promote free legal aid by suitable legislation or scheme or in any other way to ensure that opportunities for securing justice are not denied to any citizen by reason of economic or other disabilities.

Humane Conditions at Work:-

Article 42 directs the State to make provision for securing justice and humane conditions of work and for maternity relief.

Fundamental Duty:-

Article 51A (e)enjoins upon every citizen to renounce practices derogatory to the dignity of women.

Reservation of seats for Women in Panchayats and Municipalities:-

Article 243 D (3) and Article 243 T(3) provide for reservation of not less than one third of total number of seats in Panchayats and Municipalities for women to be allotted by rotation to different Constituencies.

Article 243 D(4) T(4) provides that not less than one third of the total number of officers of chairperson in the Panchayat and Municipalities at each level to be reserved for women.

Voting rights/Electoral law:-

Not less than one-third seats shall be reserved for women. Such seats may be allotted by rotation to different constituencies in a Panchayat.

The office of the chairperson in the Panchayat at the village or any other level shall be reserved for SCs, STs and women in such manner as the legislature of state may, by law provide.

Reservation of seats for women in Municipalities is provided:-

To uphold the Constitutional mandate, the state has enacted various legislative measures intended to ensure equal rights, to counter social discrimination and various forms of violence and

atrocities and to provide support services especially to working women. Although women may be victims of any of the crimes such as 'Murder', 'Robbery', 'Cheating' etc, the crimes, which are directed specifically against women, are characterized as 'Crime against Women'. These are broadly classified under two categories.

Legal Rights to Women: The following various legislation's contained several rights and safeguards for women:-

Protection of Women from Domestic Violence Act (2005) is a comprehensive legislation to protect women in India from all forms of domestic violence. It also covers women who have been/are in a relationship with the abuser and are subjected to violence of any kind physical, sexual, mental, verbal or emotional.

Immoral Traffic (Prevention) Act (1956) is the premier legislation for prevention of trafficking for commercial sexual exploitation. In other words, it prevents trafficking in women and girls for the purpose of prostitution as an organised means of living.

Indecent Representation of Women (Prohibition) Act (1986) prohibits indecent representation of women through advertisements or in publications, writings, paintings, figures or in any other manner.

Commission of Sati (Prevention) Act (1987) provides for the more effective prevention of the commission of sati and its glorification on women.

Dowry Prohibition Act (1961) prohibits the giving or taking of dowry at or before or any time after the marriage from women.

Maternity Benefit Act (1961) regulates the employment of women in certain establishments for certain period before and after child-birth and provides for maternity benefit and certain other benefits.

Medical Termination of Pregnancy Act (1971) provides for the termination of certain pregnancies by registered medical practitioners on humanitarian and medical grounds.

Pre-Conception and Pre-Natal Diagnostic Techniques (Prohibition of Sex Selection) Act (1994)prohibits sex selection before or after conception and prevents the misuse of pre-natal diagnostic techniques for sex determination leading to female feticides.

Equal Remuneration Act (1976) provides for payment of equal remuneration to both men and women workers for same work or work of a similar nature. It also prevents discrimination on the ground of sex, against women in recruitment and service conditions.

Dissolution of Muslim Marriages Act (1939) grants a Muslim wife the right to seek the dissolution of her marriage.

Muslim Women (Protection of Rights on Divorce) Act (1986)protects the rights of Muslim women who have been divorced by or have obtained divorce from their husbands.

Family Courts Act (1984) provides for the establishment of Family Courts for speedy settlement of family disputes.

Indian Penal Code (1860) contains provisions to protect Indian women from dowry death, rape, kidnapping, cruelty and other offences.

Code of Criminal Procedure (1973) has certain safeguards for women like obligation of a person to maintain his wife, arrest of woman by female police and so on.

Indian Christian Marriage Act (1872) contain provisions relating to marriage and divorce among the Christian community.

Legal Services Authorities Act (1987) provides for free legal services to Indian women.

Hindu Marriage Act (1955) introduced monogamy and allowed divorce on certain specified grounds. It provided equal rights to Indian man and woman in respect of marriage and divorce.

Hindu Succession Act (1956) recognizes the right of women to inherit parental property equally with men.

Minimum Wages Act (1948) does not allow discrimination between male and female workers or different minimum wages for them.

Mines Act (1952) and Factories Act (1948) prohibits the employment of women between 7 P.M. to 6 A.M. in mines and factories and provides for their safety and welfare.

The following other legislation's also contain certain rights and safeguards for women:

Employees' State Insurance Act (1948)

Plantation Labour Act (1951)

Bonded Labour System (Abolition) Act (1976)

Legal Practitioners (Women) Act (1923)
Indian Succession Act (1925)
Indian Divorce Act (1869)
Parsi Marriage and Divorce Act (1936)
Special Marriage Act (1954)
Foreign Marriage Act (1969)
Indian Evidence Act (1872)
Hindu Adoptions and Maintenance Act (1956).

National Commission for Women Act (1990) provided for the establishment of a National Commission for Women to study and monitor all matters relating to the constitutional and legal rights and safeguards of women.

Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal). Act (2013) provides protection to women from sexual harassment at all workplaces both in public and private sector, whether organised or unorganized.

Reference:-

https://www.womenlawsindia.com/legal-awareness/women-rights-in-india/
https://amritmahotsav.nic.in/blogdetail.htm?48
researchgate.net/publication/353832603_Legal_status_and_rights_of_women_in_Indian_Constitution
Indian Constitution by Dr. BabasahebAmbedkar